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NORTH
AMERICAN
DRÄGER

TECHNICAL SERVICE MANUAL

NARKOMED 2A
ANESTHESIA SYSTEM

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INTRODUCTION

This manual was prepared to provide authorized NAD service representatives with the necessary information to maintain and repair NAD anesthesia and related equipment at the customer's premises. North American Dräger suggests that the entire manual be studied before attempting any major repairs. Many procedures require identical steps which must be followed, and reference may be made to another procedure in this manual.

The information in this manual covers primarily the NARKOMED 2A, since most features of other anesthesia machine models are incorporated in this equipment. It may be possible that some anesthesia apparatus will vary somewhat from the standard equipment described in this manual. Variations of standard design are occasionally found when the equipment was manufactured to meet the customer's needs. However, the basic principles of NAD's equipment design remain the same.

When replacing parts with critical component dates, please observe the following:

1. Record critical component date of part which was removed
2. Record critical component date of replacement part
3. Enter the above information in your file under the model and serial number of the respective equipment

When technical assistance is required or when ordering replacement parts, refer to your Parts List and contact:

North American Dräger
Technical Service Department
1-800-543-5047

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Description of Equipment

The NARKOMED 2A Anesthesia System is a device to allow the administration of anesthetic and non-anesthetic gases to patients. If equipped with vaporizers, the machine is also capable of delivering anesthetic agents in form of vapors in conjunction with these gases. The Vapor vaporizer converts a liquid anesthetic into a measured amount of vapor, which is carried to the patient in the predetermined gas mixture.

An Absorber System accepts exhaled patient gases and removes the exhaled carbon dioxide. This allows for readministration of a portion of the exhaled gas in combination with fresh gas mixtures.

The Ventilator allows the operator to mechanically control the patients ventilation. The operator can preset the tidal volume, inspiratory flow rate, I/E ratio and frequency. The use of the ventilator eliminates the task of manual ventilation by rythmically squeezing the anesthesia breathing bag.

An Oxygen Monitor is used to determine the inhaled oxygen concentration and helps to prevent the administration of gas mixtures with insufficient oxygen.

The Scavenger Interface prevents the discharge of waste gases into the atmosphere. These waste gases are instead channeled into the vacuum system via the Scavenger Interface.

The electrically powered alarm panel contains numerous indicators to alert the operator in such cases as a disconnected breathing tube, high system pressure, oxygen supply failure and other potentially dangerous situations.

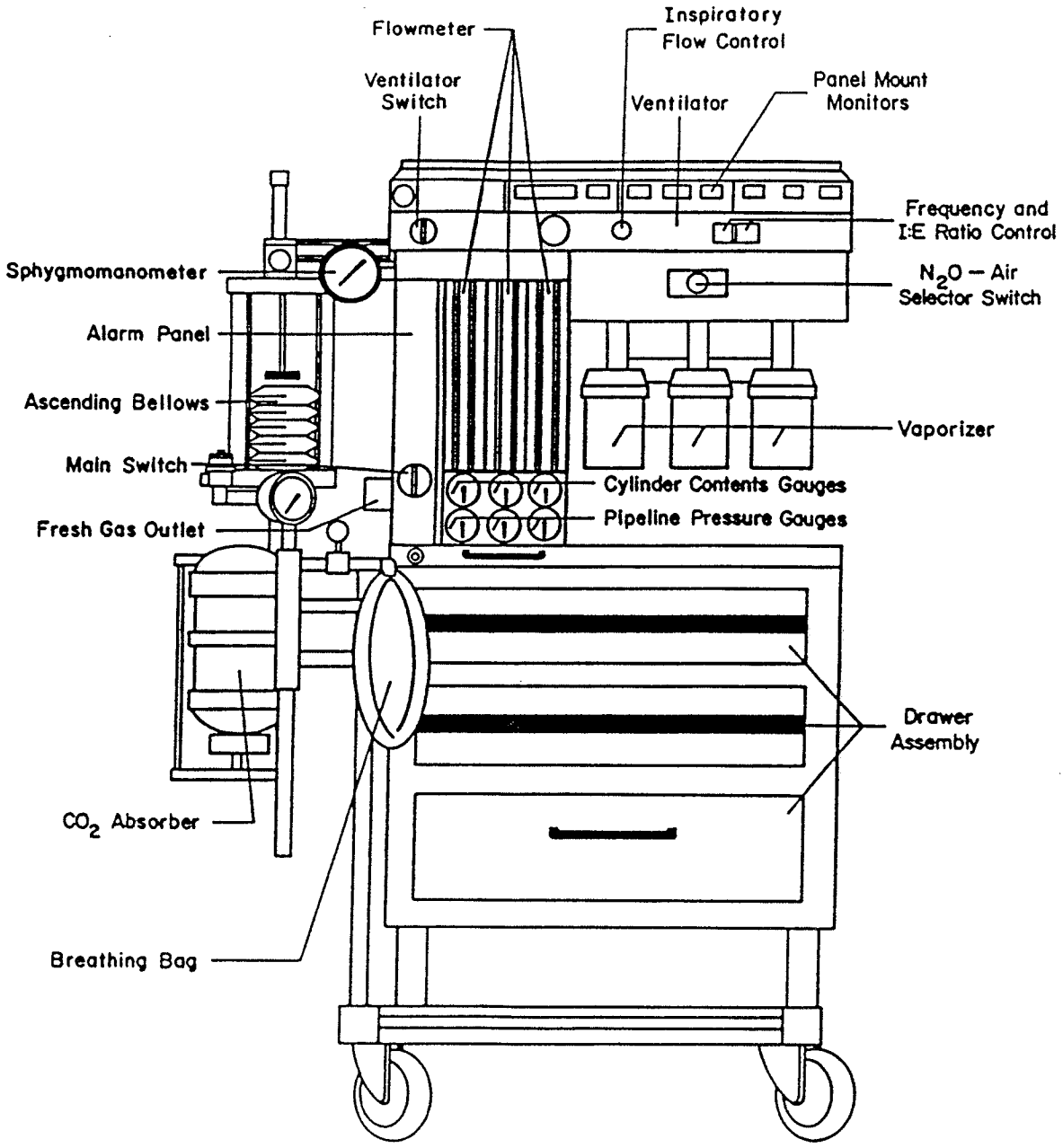
The anesthesia system is normally operated with pressurized medical gases from a central supply system. Oxygen is the prime gas. If a failure of the central oxygen supply system occurs, the anesthesia machine will then automatically shut off all other gases and warn the operator of such oxygen supply failure. By activating the oxygen cylinder, which is attached to the anesthesia machine, the unit is again functional and the supply of all other gases is automatically restored.

If an electrical power failure should occur, the battery back-up system will automatically supply electric power to all electric and electronic components of the anesthesia machine with the exception of certain monitors and the 2 (two) 117 VAC receptacles in the power pack. The reserve power will allow the operator to conclude the current procedure safely.

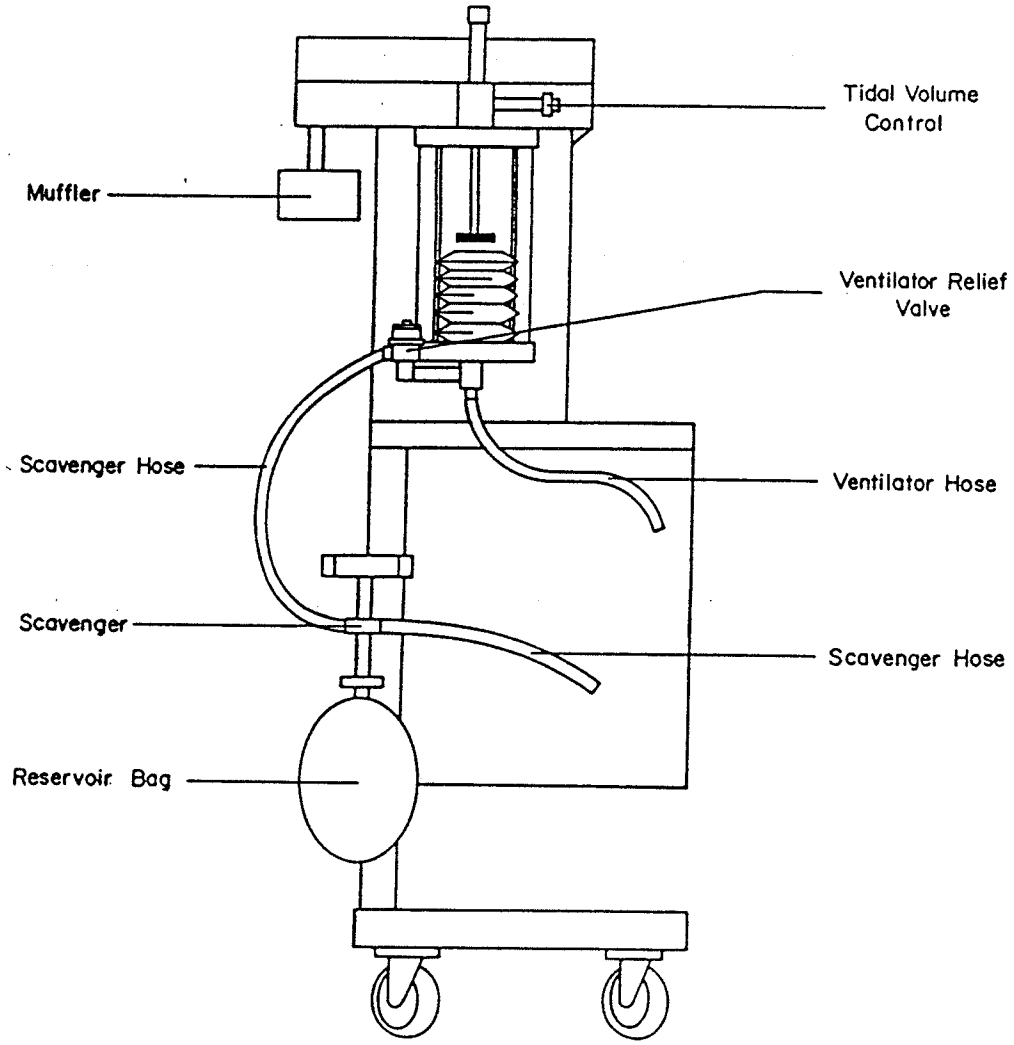
If the NARKOMED 2A is equipped with a data communication network system, all alarm functions will be centrally displayed in a predetermined order.

NARKOMED 2A

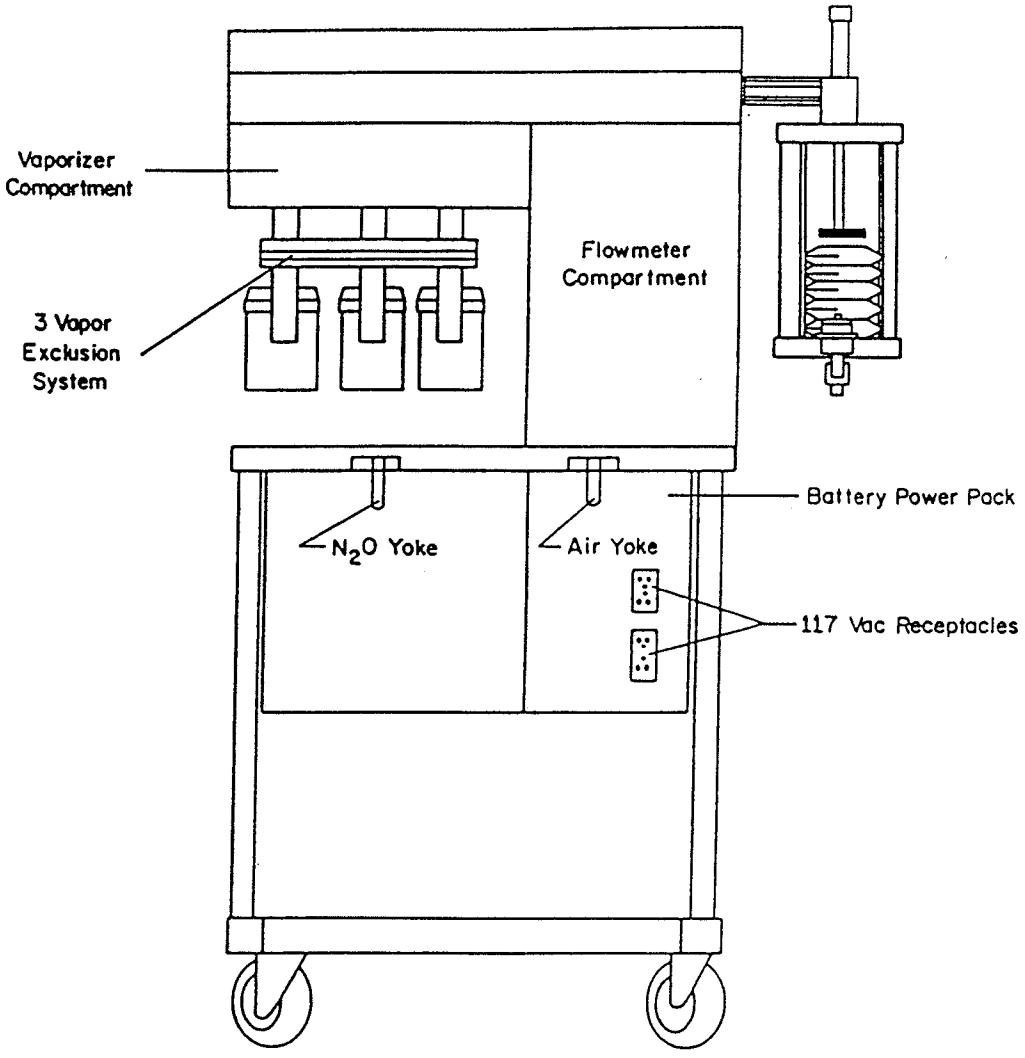
Front View



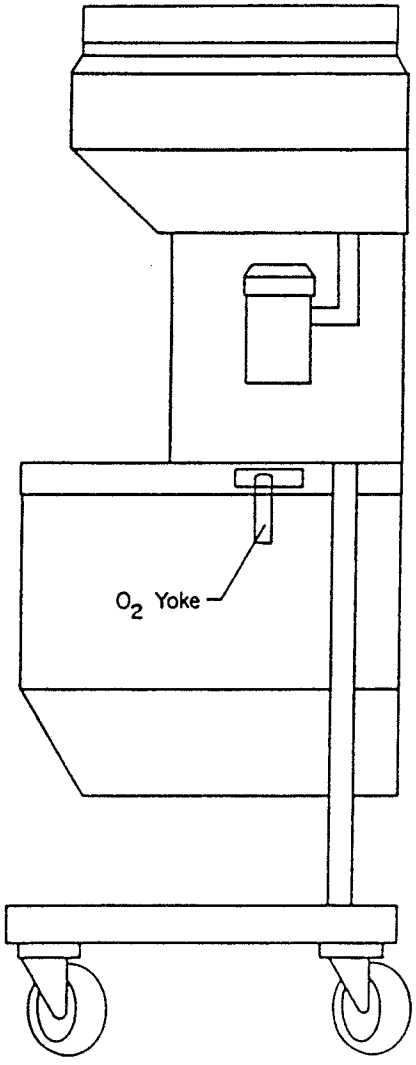
NARKOMED 2A
Left Side



NARKOMED 2A
Rear View



NARKOMED 2A
Right Side



Safety Precautions

Do's	Don'ts
When moving anesthesia machine - Always touch handles and pull machine while walking backwards	Never handle machine by pulling or pushing accessories Never push machine into elevators, rooms, etc.
Always unplug pressure hoses and electric cords before moving equipment	Never move machine without having all hoses and cords secured
Always turn cylinders off and drain system of residual gases before moving equipment	Never leave cylinders turned on while moving equipment
Always turn flow valves, vaporizers, monitors, ventilator and main switch off when machine is not in use	Never leave main switch turned on when equipment is not attended
Always activate oxygen flush for several seconds after the anesthesia system was shut down	Never leave residual gases other than oxygen in the anesthesia breathing system after completion of procedure
Always clean your hands thoroughly before servicing anesthesia equipment	
Use only Lubricants as specified by NAD	Never use oil or other lubricants on equipment which comes in contact with oxygen. Oil and oxygen under pressure can be explosive
Service equipment only in a well ventilated area	Avoid inhalation of vapors and gases
Replace malfunctioning cylinder regulators	Never attempt to repair high pressure cylinder regulators
Send Vapor vaporizers to NAD for service	Never attempt to disassemble, repair, or recalibrate Vapor Vaporizers
Drain and dry vaporizers before transport (see Vapor vaporizer test procedure)	
	Never operate the anesthesia machine, unless the electrical power cord is plugged into a 117 VAC receptacle

Operation of Equipment

1.0. Basic Requirements

1.1. The operation of the equipment requires careful study of all appropriate instruction manuals

1.2. A patient breathing circuit with Y-piece, 2 (two) Drager Training Thorax's or equivalent to simulate the patient's lung functions and a breathing bag must be connected to the NARKOMED 2A anesthesia machine

1.3. 50 psi oxygen, nitrous oxide and air pressure sources must be connected to the appropriate DISS gas inlets on the anesthesia machine.
Small medical gas cylinders for oxygen, nitrous oxide and air must be connected to the appropriate yokes.
Do not fill vaporizers with liquid anesthetic agent

1.4. All switches and valves on the NARKOMED 2A Anesthesia Machine must be turned to the following positions:

Main switch OFF (9 o'clock position)
APL Valve open (fully counterclockwise)
N_2O/Air Selector Switch set to N_2O position
Flow control valves closed (fully clockwise)
Manual/Automatic Selector Valve to BAG
Minimum Ventilation Pressure Switch to lowest cm H_2O setting
Vaporizers to 0 (zero) position
Ventilator Switch OFF (9 o'clock position)
Tidal Volume Control to 500cc
Inspiratory Flow Control OFF (fully counterclockwise)
Frequency Control to 10 BPM
I:E Ratio Control to 1:2
Small gas cylinders OFF (fully clockwise)

2.0. Start-Up Procedure

2.1. Connect gas pressure hoses to central piping system and check pipeline pressure gauges

2.2. Plug electrical cord into 117 VAC outlet

2.3. Connect the central vacuum system to the scavenger interface and close the vacuum control valve

2.4. Turn the main switch on. With all flow control valves still in the OFF position, a minimum oxygen flow of approximately 250 to 300cc will be administered

2.5. Turn N_2O/Air selector switch to Air position. The minimum oxygen flow will stop. Turn the N_2O selector switch again to the N_2O position
The minimum oxygen flow is only activated when O_2/N_2O mixtures are administered. No minimum oxygen flow is required in conjunction with air since air already contains 21% oxygen. Therefore, no danger exists, that a hypoxic gas mixture may be administered (for oxygen concentrations in O_2 /Air mixtures see **Specifications/Tolerances** in the Service Manual)

2.6. Calibrate oxygen monitor. If the entire breathing system is charged with pure oxygen the oxygen monitor should read 100% O_2

3.0. Manual Ventilation

3.1. Set oxygen flow to 3 l/min and nitrous oxide flow to 3 l/min (Oxygen monitor will read 50% O_2)

3.2. Fill breathing bag with gas mixture and turn APL valve clockwise until it is almost closed (If bag fills too slowly, activate the oxygen flush button and fill the breathing bag)

3.3. Slowly squeeze the breathing bag and observe the training thorax expand. Also observe the absorber pressure gauge. Several cm H_2O positive pressure should develop during inspiration

3.4. Relax the breathing bag. Air will leave the training thorax and the bag will fill again

3.5. At this time check the scavenger interface. Open the needle valve so that the reservoir bag does not collapse completely during inspiration or over inflate during expiration

3.6. Ventilate the patient (training thorax) and change oxygen flow, APL valve setting, respiration rate, lung compliance or lung resistance, see 4.6

3.7 Turn the nitrous oxide flow valve to maximum (oxygen flow still at 3 l/min.) The O.R.M.c. alarm will be activated and at one point the nitrous oxide flow will not increase any further (approximately at 7 l/min N_2O) The oxygen monitor will indicate 28% ± 3% oxygen concentration

3.8. Increase the oxygen flow. The alarm will eventually cease - or decrease the nitrous oxide flow and the alarm will also cease

3.9. Set O_2 flow to 3 l/min and N_2O flow to 7 l/min. Slowly decrease the oxygen flow. As the oxygen flow decreases so will the nitrous oxide flow. At approximately 500cc O_2 the N_2O flow will completely stop, while the N_2O flow valve is still open

3.10. If an O.R.M. instead of an O.R.M.c. is used, an alarm will be activated when the oxygen concentration drops below 30% ± 5%. The nitrous oxide flow is not automatically controlled

3.11. Set O_2flow to 4 l/min and N_2O flow to 10 l/min. Disconnect the oxygen supply source and observe the pipeline pressure gauge. The O_2 supply pressure alarm will be activated as the oxygen pressure drops. Simultaneously, as the oxygen flow drops, the nitrous oxide gas flow will drop. This safety feature is caused by the oxygen failure protection device

3.12. Turn N_2O/Air selector switch to Air position and turn the air flow control valve on. No air will flow

3.13. Restore oxygen supply. Immediately an air flow is available. Air is also controlled by an oxygen failure protection device

3.14. Turn N_2O/Air switch to N_2O position. Immediately the nitrous oxide will flow

3.15. Disconnect the oxygen supply source and turn on the small oxygen cylinder. All gases will be restored

4.0. Automatic Ventilation

4.1. Turn OFF the nitrous oxide flow and set oxygen flow to 4 l/min

4.2. Turn ventilator switch to 12 o'clock position

4.3. Set inspiratory flow rate to center of medium on flow gauge

4.4. Set manual/automatic selector valve to AUTOMATIC position. The patient (training thorax) is now mechanically ventilated

4.5. Disconnect the breathing tube from the inspiratory valve on the CO_2 absorber. After 15 (fifteen) seconds the minimum ventilation alarm will be activated. The alarm will cease when the breathing tube is connected again

Automatic Ventilation

4.6. Change tidal volume, inspiratory flow rate, frequency, I:E ratio, lung compliance and resistance to create numerous ventilatory patterns

5.0. Shut-Down Procedure

5.1. Turn ventilator switch OFF

5.2. Disconnect nitrous oxide and air supply hoses

5.3. Turn nitrous oxide and air cylinders OFF

5.4. With N_2O/Air selector switch in air position, turn oxygen flow to 3 l/min and air flow control to maximum. As soon as air flow has ceased, close air flow control valve and set N_2O/Air selector switch to N_2O position

5.5. With oxygen flow at 3 l/min, set nitrous oxide flow to 5 l/min. As soon as nitrous oxide flow has ceased, close nitrous oxide and oxygen flow control valves

5.6. Turn main switch OFF

5.7 Disconnect oxygen supply hose and turn the small oxygen cylinder OFF

5.8. Activate the oxygen flush button until oxygen flow ceases

5.9. All pipeline and cylinder gauges must indicate 0 (zero) pressure

5.10. Remove patient circuit and training thorax

5.11. Unplug and store power cord

Clinical Application of Anesthesia System

The NARKOMED 2A Anesthesia System is a device to allow the administration of anesthetic and non-anesthetic gases to patients. If equipped with vaporizers, the machine is also capable of delivering anesthetic agents in form of vapors in conjunction with these gases. The Vapor vaporizer converts a liquid anesthetic into a measured amount of vapor, which is carried to the patient in the predetermined gas mixture.

(See the schematic **Anesthesia Systems with Patient Breathing Circuit** as basis for the following text)

Before anesthesia can be administered, oxygen, nitrous oxide and if needed other medical gases must be connected to the anesthesia machine. The vaporizer(s) must be filled with anesthetic agent(s). The absorber canisters must be filled with Sodasorb. Breathing bag, patient breathing circuit and all accessory tubings and bags must be connected. After the electrical power cord is plugged in, the oxygen and other medical gases are turned on, and the vacuum line is connected to the waste gas elimination system, the anesthesia machine is ready for service.

The operator selects the oxygen/nitrous oxide gas flow which is gradually filling the breathing bag. He then connects the patient circuit to the endotracheal tube. As he squeezes the breathing bag the gas mixture moves through the CO_2 absorber and the inspiratory valve into the patient's lungs. As soon as the operator releases the breathing bag the patient exhales through the expiratory valve into the breathing bag.

In the breathing bag, the exhaled gas mixes with the fresh gas, which is flowing constantly. As soon as the bag is squeezed again the fresh and exhaled gas mixture is forced through the CO_2 absorber, where the exhaled carbon dioxide is removed and the ventilatory cycle is repeated.

During the above process, the operator may select an anesthetic agent such as Halothane, Enflurane or Isoflurane. He will turn the concentration knob to the desired volume percent concentration of the appropriate vaporizer. The predetermined gas mixture (oxygen, nitrous oxide, air) will pass through the vaporizer and carry the anesthetic vapor to the breathing bag.

The operator can also determine the inspiratory pressure for ventilating the patient by adjusting the APL valve. The wider the valve is open, the lower the pressure. The further the valve is closed, the higher the pressure. The APL valve also serves as a relief valve for excess gases. These waste gases are channeled to the scavenger interface and safely removed through the central vacuum system. Never must the APL valve be closed completely during manual or spontaneous ventilation. A complete closure of the valve will cause an excessive pressure build up.

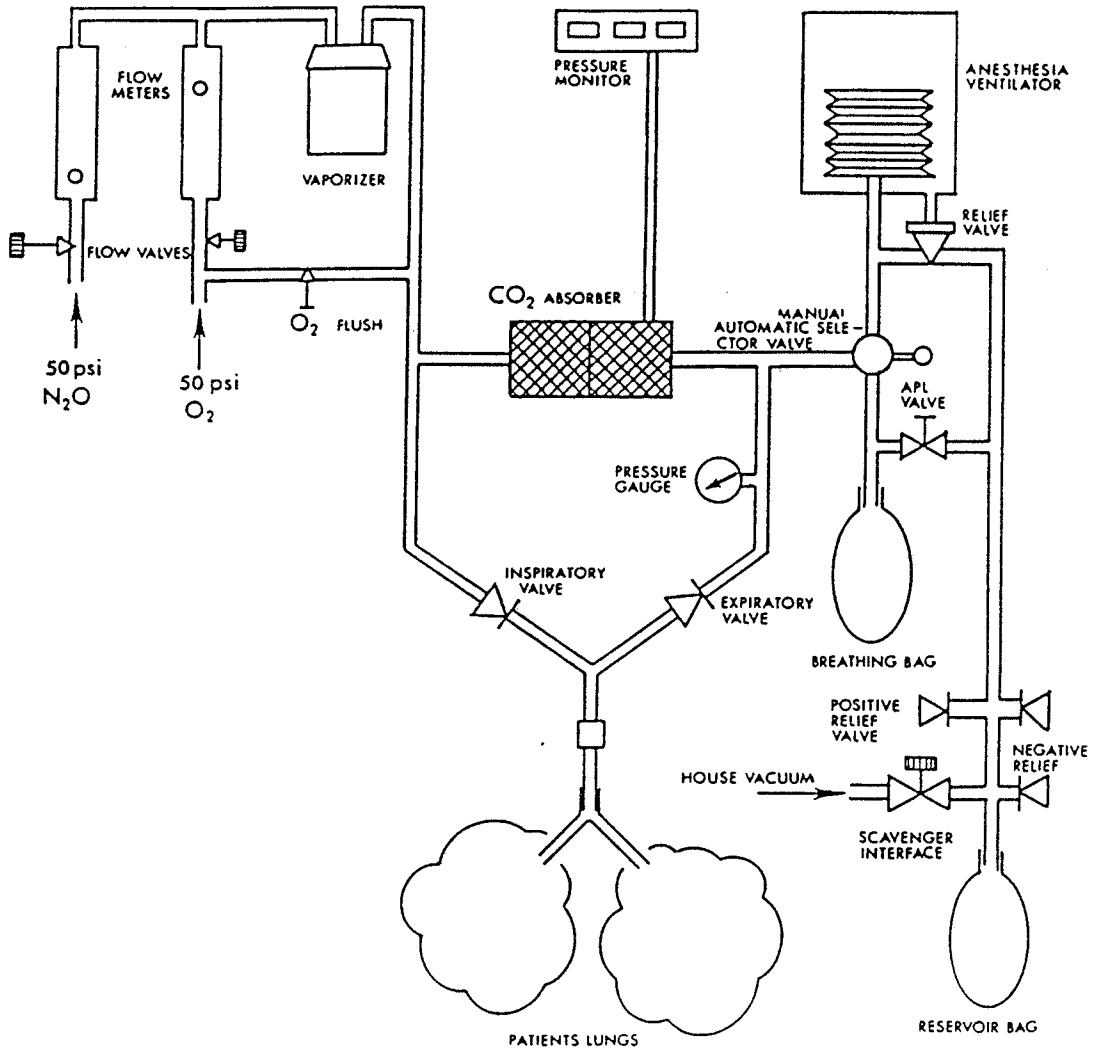
The operator can monitor pressures during the ventilatory process on the pressure gauge. A plastic tubing, which is connected to the CO_2 absorber, transfers pressures to a central pressure alarm monitor. Excessively high, negative or continuing pressures are registered and the operator is warned by an alarm signal.

The operator may also switch from manual to mechanical ventilation. He will turn on the anesthesia ventilator and preset the tidal volume, inspiratory flowrate, frequency and I:E ratio. By switching the manual/automatic selector valve to the automatic position, the patient is now under controlled mechanical ventilation. Should a tubing of the patient's breathing circuit become disconnected, the operator will be warned by the pressure monitor.

The fresh and exhaled gases no longer enter the breathing bag. They are instead channeled to the bellows of the ventilator. Since the APL valve is also by-passed together with the breathing bag, the ventilator relief valve replaces the APL valve during mechanical ventilation. Since the ventilator relief valve is automatically controlled by the ventilator, no adjustment of this valve is necessary.

Should the patient require high concentrations of oxygen instantaneously, the operator can activate the oxygen flush button. Once activated, the flowmeters and vaporizer are by-passed and oxygen is administered to the patient without anesthetics. The flush button can also be activated, even when the main switch of the NARKOMED 2A is turned OFF. This allows the operator to administer high oxygen concentration in an emergency, even after the anesthesia is already completed.

ANESTHESIA SYSTEM
WITH PATIENT BREATHING CIRCUIT



SPECIFICATIONS AND TOLERANCES

BASIC TERMINOLOGY
Abbreviations Commonly Used

APL	- Adjustable Pressure Limit Valve
AV	- Anesthesia Ventilator
AV-E	- Anesthesia Ventilator - Electronic
AVM	- Anesthesia Ventilator - Mobile
BPM	- Breath per Minute (also used: f - frequency)
cc	- Cubic Centimeters (equal to ml - milliliters)
cm H_2O	- Centimeters of Water Pressure
DISS	- Diameter Index Safety System
DPM	- Drager Pressure Monitor
DPM-S	- Drager Pressure Monitor - Self Diagnostic
HYPOXIA	- Insufficient Amount of Oxygen
I:E RATIO	- Ratio of Length of Inspiration versa Length of Exhalation
KISS	- Key Index Safety System
l/min	- Liters per Minute (total gas flow during one minute)
mm Hg	- Millimeters of Mercury Pressure
MPL	- Micro Pneumatic Logic
MV	- Minute Volumeter
NAD	- North American Drager
NMC	- Narkomed Compact
NM2	- Narkomed 2
NM2A	- Narkomed 2A
NMS	- Narkomed Standard
NMSC	- Narkomed Sub-Compact
N_2O	- Nitrous Oxide
O.F.P.D.	-Oxygen Failure Protection Device
O.R.M.	- Oxygen Ratio Monitor
O.R.M.c.	- Oxygen Ratio Monitor - Control
O_2	- Oxygen
PISS	- Pin Index Safety System
T_v	- Tidal Volume (amount of gas inhaled or exhaled with each breath)

BASIC TERMINOLOGY
Abbreviations Commonly Used

WGES	- Waste Gas Elimination System
$\dot{V}$	- Minute Volume (or minute ventilation) $\dot{V} = f \times V_T$

For detailed information, see section **Specifications/Tolerances** item Conversions

TECHNOLOGY TERMINOLOGY
Abbreviations and Definitions

Absorber	- Device to remove exhaled carbon dioxide
APL	- Adjustable Pressure Limit Valve
AV-E	- Anesthesia Ventilator - Electronic
Bellows	- Replaces breathing bag during artificial ventilation
Breathing Bag	- Reservoir in which fresh gas and exhaled gas are stored
Check Valve	- Prevents reverse gas flow
DISS	- Diameter Index Safety System
DPM-S	- Drager Pressure Monitor - Self Diagnostic
Dust Cap	- Device to collect Sodasorb dust
Endotracheal Tube	- Special tube which is inserted into the patient's trachea for ventilation purposes
Exclusion System	- Safety Device which allows the use of only one vaporizer at a time
Flow Control Valve	- a) needle valve to control fresh gas flow
	- b) ventilator valve to control inspiratory flow rate during artificial ventilation
Flowmeter	- Device to measure gas flow
Flush Button	- Device to instantly administer high concentrations of oxygen
Fresh Gas	- Mixture of anesthetic gases and vapors
KISS	- Key Index Safety System
Manual/Automatic	- Valve for the selection between manual and artificial ventilation
MPL	- Micro Pneumatic Logic
MV	- Minute Volumeter
NAD	- North American Drager
NM2A	- Narkomed 2A
O.F.P.D.	- Oxygen Failure Protection Device
O.R.M.	- Oxygen Ratio Monitor
O.R.M.c.	- Oxygen Ratio Monitor - Control
Pipeline	- Cenralized medical gas system
PISS	- Pin Index Safety System
Power Pack	- Electrical supply with reserve battery
Pressure Gauge	- Device to measure gas pressure
Sodasorb	- Material which retains exhaled carbon dioxide (for absorber cannisters)
Vaporizer	- Device to produce a vapor from a liquid anesthetic agent

TECHNOLOGY TERMINOLOGY ABBREVIATIONS AND DEFINITIONS

Ventilator	- Mechanical device to provide artificial ventilation
Ventilator Relief Valve	- Replaces APL valve during artificial ventilation
WGES	- Waste Gas Elimination System (Scavenger Interface)
Yoke	- Device to mount medical gas cylinder

MEDICAL TERMINOLOGY
Definitions and Symbols

Apnea	- Cessation of respiration
*cc	- Cubic Centimeters (1/100 of a liter is 1cc)
*cm H_2O	- Centimeters of Water Pressure (ventilatory pressure)
Compliance	- Changes to pressure
CO_2	- Carbon Dioxide
CPAP	- Continuous Positive Airway Pressure
Diastolic Blood Pressure	- Lowest blood pressure during a cardiac cycle (heart beat)
Expiration	- Exhalation
Expiratory Flow Rate	- Rate at which gas is exhaled (l/min)
Expiratory Pause	- Time period from complete exhalation until inhalation starts
Expiratory Time	- Time which is required to exhale all of the inhaled gas (Tidal Volume)
Frequency	- Breath per minute (f)
HYPOXIA	- Insufficient Amount of Oxygen
I:E RATIO	- Ratio of Length of Inspiration versa Length of Exhalation
Inspiration	- Inhalation
Inspiratory Flow Rate	- Rate at which gas is inhaled (l/min)
Inspiratory Pause	- Time period from complete inhalation until expiration starts
Inspiratory Time	- Time which is required to inhale a certain amount of gas (Tidal Volume)
*l/min	- Liters per Minute (total gas flow during one minute)
Minute Volume	- Amount of gas inhaled or exhaled during one minute, (V) (also called minute ventilation; $V = f \times T_v$
*ml	- Milliliter (1/1000 of a liter is 1 ml
*mm Hg	- Millimeters of Mercury Pressure (for blood pressures)
N_2	- Nitrogen
O_2	- Oxygen
PEEP	- Positive End Expiratory Pressure
P_A	- Alveolar pressure (gas pressure in part of lung where O_2 enters the blood and CO_2 is removed from the blood)
PCO_2	- Partial pressure of carbon dioxide (in the blood)
pH	- Indications as to the acidity or alkalinity of a solution (blood)
PO_2	- Partial pressure of oxygen (in the blood)

MEDICAL TERMINOLOGY
DEFINITIONS AND SYMBOLS

Ps	- System pressure (gas pressure in patient's breathing system)
Pulse	- Number of heart beats per minute
Respiration	- Gas exchange in the lungs
Respiration Cycle	- Time interval from beginning of inspiration to beginning of next inspiration
Systolic Blood Pressure	- Highest blood pressure during a cardiac cycle (heart beat)
Tidal Volume	- Amount of air inhaled or exhaled with each breath (T_v)
Ventilation	- Movement of gas in and out of the lungs

*For detailed information see **Specifications/Tolerances**, item 3.2 in the Service Manual

1.0. Pneumatic Specifications

1.1. Pipeline Pressure Requirements

Oxygen: 50psi -0, + 5psi
Nitrous Oxide: 50psi ± 5psi
Air: 50psi ± 5psi

1.2. Cylinder Regulators

At gas flow of 4 l/min:	O_2	N_2O
No O.R.M. or O.R.M.c.	40psi	40psi
O.R.M.	45psi	45psi
O.R.M.c.	48psi	45psi

1.3. Oxygen Flush

Measured on common gas outlet - minimum 50 l/min

1.4. Minimum Oxygen Flow

275 ± 50cc per minute (Depending on pipeline pressure)

1.5. Flowmeters

± 3% of full scale reading at 760 mm Hg 20° C

1.6. Absorber System

Maximum allowable leak: 20cm H_2O in 30 seconds at pressure above 50cm H_2O

1.7. APL Valve

Maximum resistance: 2cm H_2O with valve fully open

1.8. High Pressure System

Maximum allowable leak with full cylinder: 50psi in 2 minutes

1.9. Ventilator Pressure

Ventilator setting: f = 10 BPM
Tv = approx. 1 liter
ventilator flow = maximum of low
O_2 flowrate = 3 l/min
Minimum pressure on inspiration: 30cm H_2
Maximum pressure on exhalation: 2cm H_2O

1.10. Vapor Vaporizers

All Volume% concentrations:
Halothane ± 15%
Enflurane ± 15%
Isoflurane ± 20%

1.11. O.R.M.c.

Oxygen concentration alarm threshold 28 ± 3% O_2 concentration, but never less than 25% O_2 concentration

Pneumatic Specifications

1.12. O.R.M.

Oxygen concentration alarm threshold 30 ± 5% concentration

1.13. MPL Switches

Switches below 15cm H_2O ± 15%
Switches above 15cm H_2O ± 10%

2.0. Electronic Specifications

2.1. NAD Oxygen Monitor

Meter Linearity: ± 1 - 1.5% full scale
Response Time: 97% in 10 seconds
Drift Rate: ± 1% full scale in 8 hours
Power Requirements: 3 Mercury Batteries - 4.05 V each

2.2. Alarm Delays on NM2A

10 second delay: ± 1 second
15 second delay: ± 1.5 seconds
30 second delay: ± 5.0 seconds
60 second delay: ± 6.0 seconds

2.3. NM2A Power

Primary: 117 VAC, 60 Hz
Secondary: 10-17 VDC, unregulated
Service Voltage: 5 VDC, regulated
Receptacles: 117 VAC (located in rear power supply)
Receptacles: 12 VDC, unregulated for NAD monitors
Reserve Power Supply: 12 Volt Lead-dioxide-acid, gelled battery
Circuit Breaker CB1: 1 AMP, 2 pole, transformer primary
Circuit Breaker CB2: 10 AMP, 2 pole, 117 VAC receptacles
Circuit Breaker CB3: 2 AMP, 1 pole, back-up battery
Circuit Breaker CB4: 1.5 AMP, 1 pole, ventilator, alarm panel, flowmeter, lights, Oxymed
Circuit Breaker CB5: 2 AMP, 1 pole, Spiromed
Fuse: ½ AMP slowblow, 17 Volt secondary of transformer

2.4. Electrical Conductivity

Measuring Points: caster and table top
caster and shelf top
caster and inspiration valve

Maximum allowable resistance between any of these two points: 250,000 OHMS

3.0. Conversions

3.1. Oxygen Concentrations at Various Oxygen/Air Flow Ratios

$$\frac{\text{Air l/min} \times 21 + \text{O}_2\text{ l/min} \times 100}{\text{Total Liter Flow}} = \%\text{O}_2$$

OXYGEN L/MIN	AIR L/MIN	PER CENT OXYGEN CONC
.3	10.0	23.3%
.5	10.0	24.8%
.8	10.0	26.9%
1.0	10.0	28.2%
2.0	10.0	34.2%
3.0	10.0	39.2%
4.0	10.0	43.6%
5.0	10.0	47.3%
6.0	10.0	50.6%
7.0	10.0	53.5%
8.0	10.0	56.1%
9.0	10.0	58.4%
10.0	10.0	60.5%
1.0	1.0	60.5%
1.0	2.0	47.3%
1.0	3.0	40.8%
1.0	4.0	36.8%
2.0	1.0	73.6%
2.0	2.0	60.5%
2.0	3.0	52.6%
3.0	1.0	80.3%
3.0	2.0	68.4%
3.0	3.0	60.5%

3.2. Conversion Factors

1 atm = 1033cm H_2O = 760mm Hg = 760 Torr = 1013 mb = 14.7psi
1 psi = 70.3cm H_2O = 51.7mm Hg = 68.9 mn = 6.9 kPa
1 mm Hg = 1.36cm H_2O = 1.02 mb
1 cm H_2O = 0.736mm Hg = 0.981 mb

OPERATING PRINCIPLES OF ANESTHESIA AND RELATED EQUIPMENT

OPERATING PRINCIPLES

1. Introduction
2. Flow Control Valve
3. Pressure Reducing Regulator
4. Central Medical Gas Supply
5. Oxygen Failure Protection Device
6. Minimum Oxygen Flow
7. O.R.M. and O.R.M.c.
8. Gas Piping System of NARKOMED 2A
9. Venturi
10. NAD Anesthesia Ventilator
11. NAD CO_2 Absorber System
12. Scavenger Interface
13. Vapor Vaporizer 19.1

THEORY OF OPERATION

Introduction

The following sections explain in detail the theory of operation of individual pneumatic components as well as the entire pneumatic system of the North American Drager NARKOMED 2 and NARKOMED 2A Anesthesia Systems.

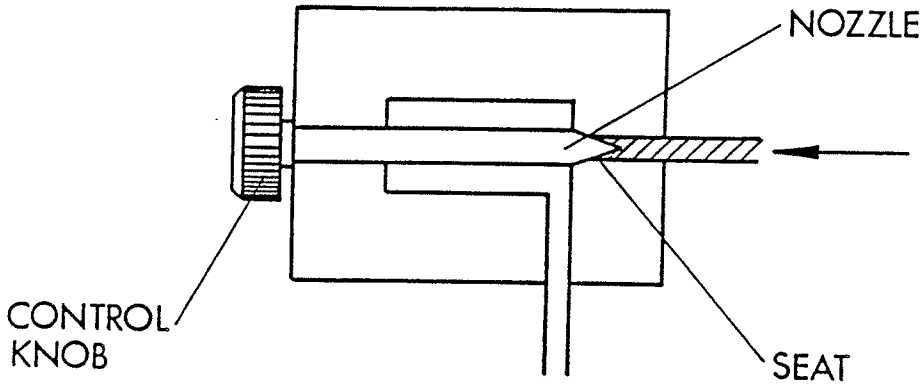
Many of the working principles described in the following chapters apply also to other similar anesthesia and respiratory equipment.

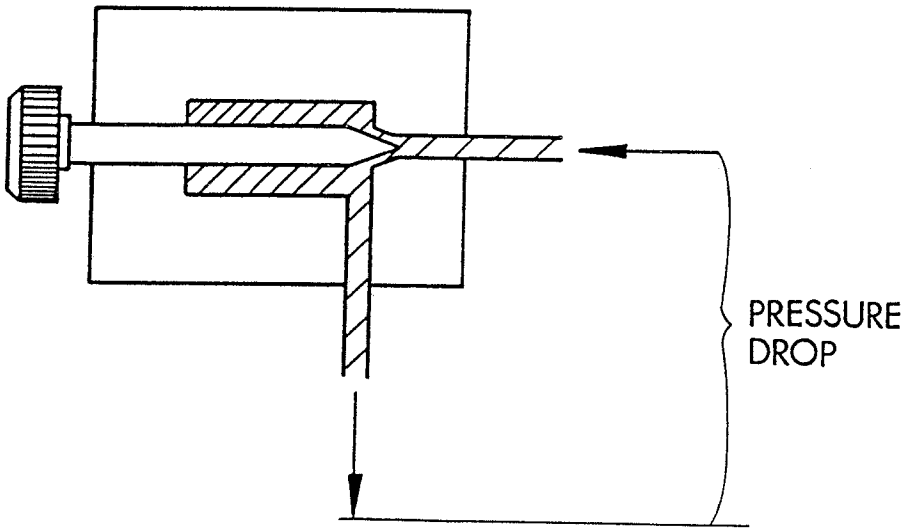
The piping diagrams show the basic operating principle and may vary from equipment to equipment, depending on manufacturer's design, production modifications, changes of equipment standards or customer's preference.

FLOW CONTROL VALVE

(Needle Valve)

FLOW CONTROL (NEEDLE VALVE)





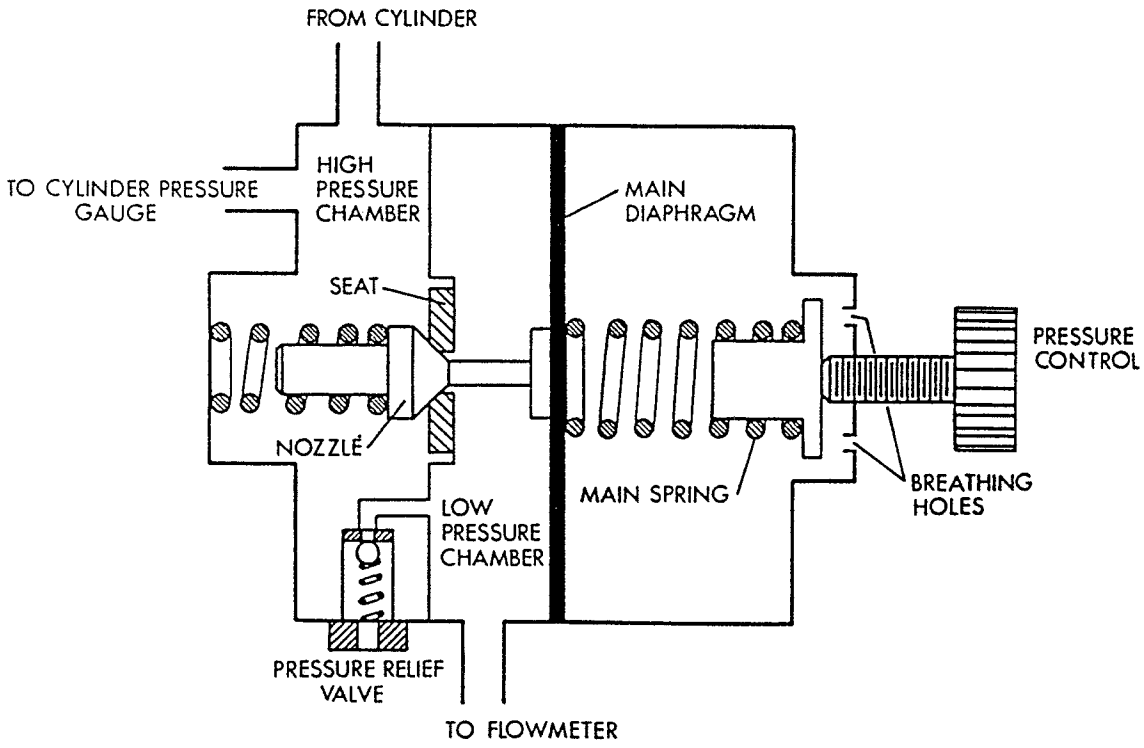
FLOW CONTROL (NEEDLE VALVE)

The flow control or needle valve is a precision machined device, which controls the gas flow through a variable size orifice. While the seat is stationary, the nozzle can be moved by turning the flow control knob. The farther the distance between nozzle and seat the higher the gas flow down stream of the valve. The smaller the distance the lower the gas flow. When the control knob is completely turned clockwise the nozzle will be pressed against the seat and the gas flow will stop.

A pressure drop occurs across the seat/nozzle assembly, or in other words, between the upstream and the downstream side of the valve. If the downstream port of the valve is occluded, the gas flow will stop and the pressure downstream of the seat/nozzle assembly will be the same as upstream.

PRESSURE REDUCING REGULATOR

PRESSURE REDUCING REGULATOR



PRESSURE REDUCING REGULATOR

The pressure reducing regulator is a device which decreases a high pressure (e.g. 2000 psi) to a relatively low operating pressure (e.g. 50 psi)

The single stage regulator which is the simplest and most commonly used regulator in anesthesia equipment is divided into 2 (two) sections:

1. The high pressure chamber which contains the seat and nozzle assembly.
2. The low pressure chamber which is seperated by a diaphragm from the main spring and the pressure control knob.

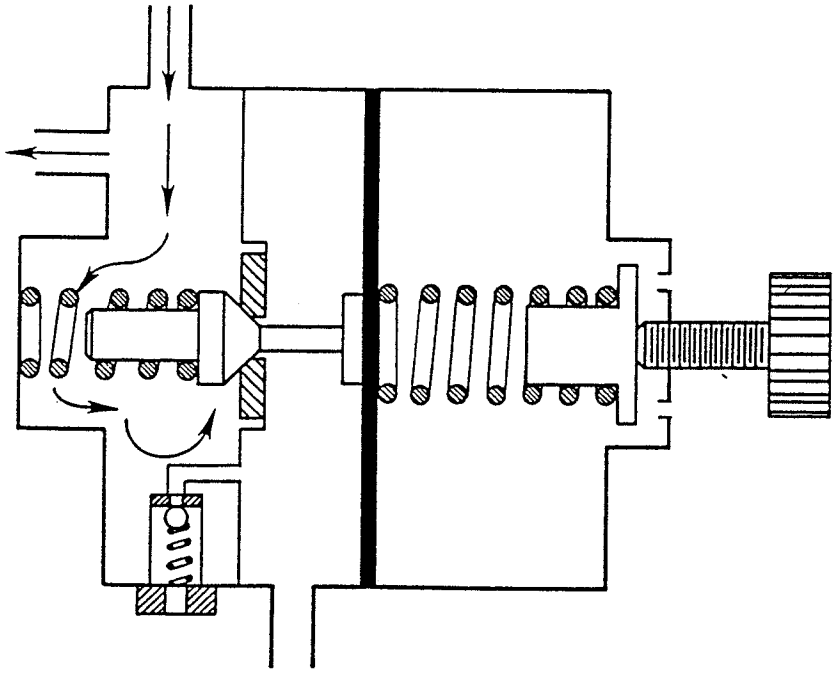
The diaphragm and nozzle are connected with each other in such a manner that all motions of the nozzle are synchronized with the diaphragm.

The design of the seat/nozzle assembly determines the maximum gas flow which may be obtained at any given pressure setting.

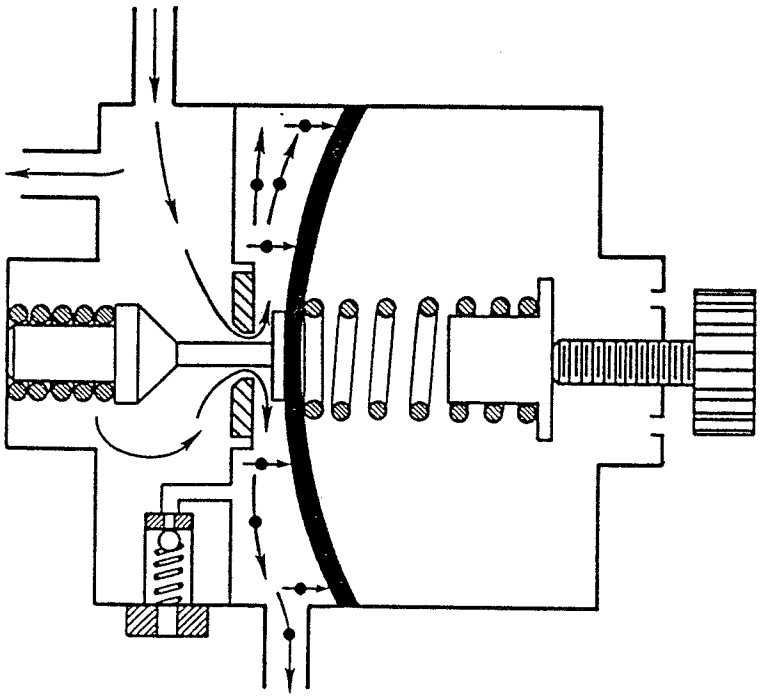
A preset pressure relief valve will prevent a pressure build-up in the low pressure chamber in case gas leakage is caused by a faulty seat/nozzle assembly while the regulator is turned OFF.

The breathing holes allow for free air movement between the atmosphere and the regulator housing to maintain ambient pressure independent from the position of the diaphragm.

Pressure gauges are usually utilized on the high and low pressure sides of the regulator. The high pressure gauge (cylinder pressure) shows the regulator input pressure while the low pressure gauge is used to determine the desired regulator output pressure. Many single stage pressure reducing regulators are preset by the manufacturer to a predetermined output pressure and do not require a low pressure gauge.



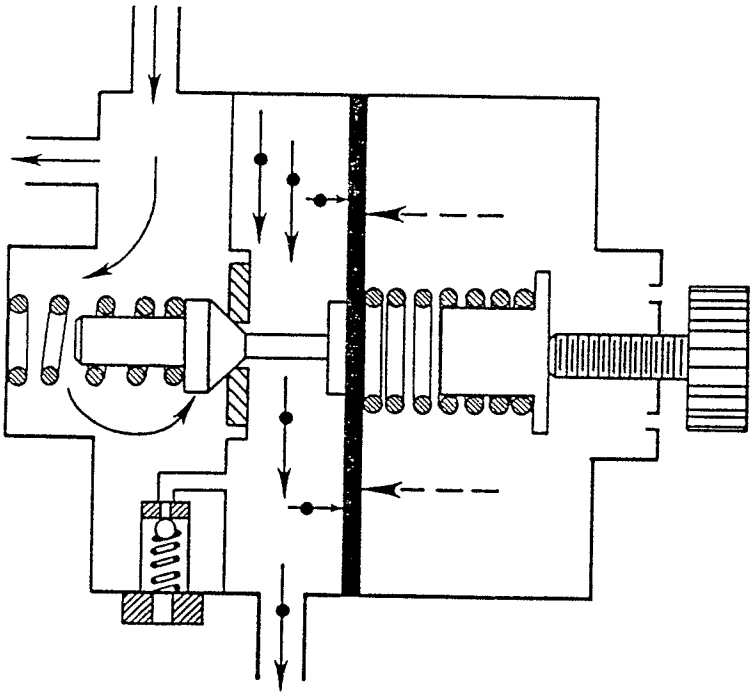
high pressure



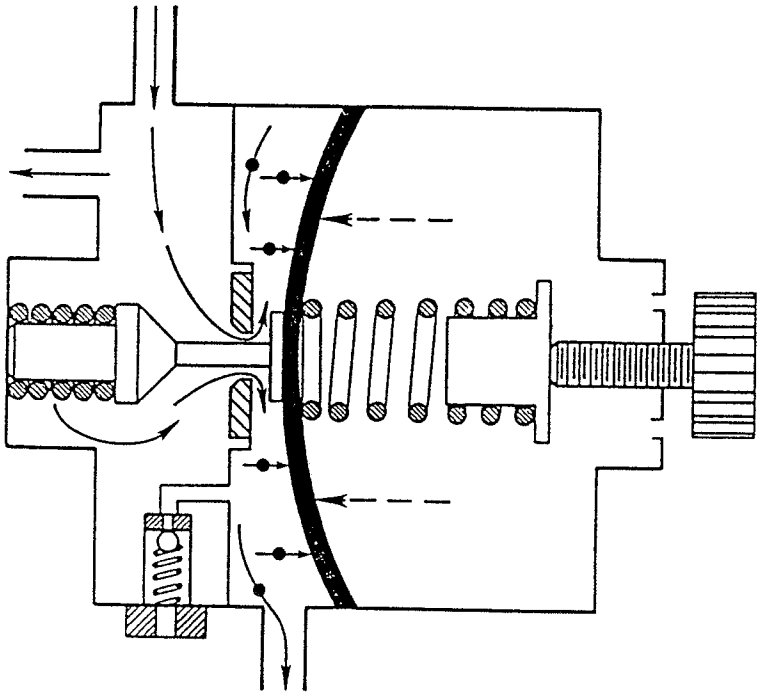
high pressure
low pressure (controlled)

With the regulator control in the OFF position (pressure control turned counterclockwise) the pressure reducing regulator is connected to a high pressure gas source (e.g. 2000 psi). The high pressure gas enters the high pressure chamber and high pressure gauge. Since the main spring is relaxed, no pressure is applied on the diaphragm. The nozzle is therefore pressed against the seat and gas is prevented from entering the low pressure chamber.

As the regulator control is turned ON (pressure control being turned clockwise) pressure is applied against the diaphragm which forces the nozzle away from the seat. Gas can now enter the low pressure chamber, where the pressure begins to increase.



high pressure
low pressure (controlled)
main spring pressure



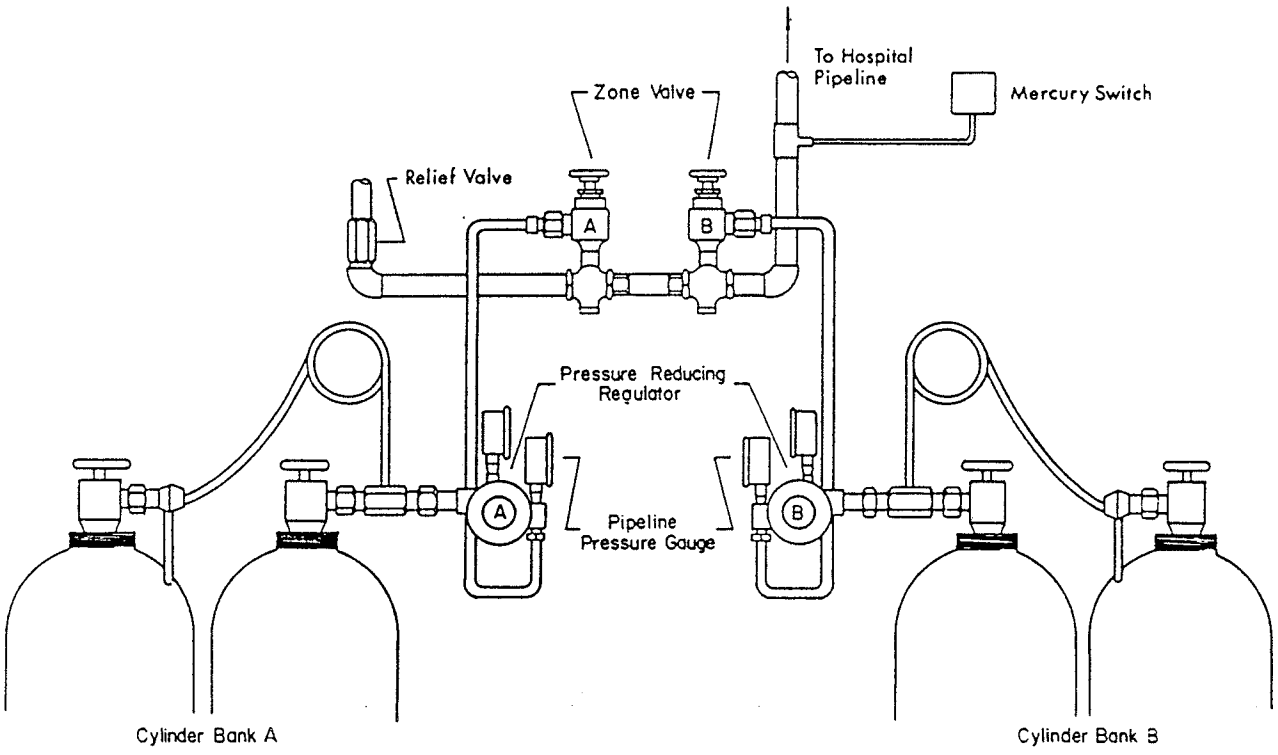
high pressure
low pressure (controlled)
main spring pressure

The pressure increase in the low pressure chamber will force the diaphragm into the opposite direction which results in the compression of the main spring. During this process, the nozzle is gradually moving towards the seat which reduces the gas flow into the low pressure chamber. Once the gas pressure in the low pressure chamber is equal to the pressure of the main spring, the diaphragm is flat again and the nozzle is pressed against the seat which prevents more gas from entering the low pressure chamber.

As gas is leaving the low pressure chamber to activate the appropriate appliance (e.g. flowmeter), the pressure in the low pressure chamber begins to drop. This allows the main spring to force the diaphragm towards the low pressure chamber which also opens the seat/nozzle assembly. Gas can again enter the low pressure chamber and the entire process as described in this chapter is repeated.

NOTE: It is important to select the correct regulator for a given appliance. Not only must the regulator provide the required low pressure but also contain a seat/nozzle assembly which is capable of supplying gas flows in excess of total gas flow requirements.

CENTRAL MEDICAL GAS SUPPLY


To Hospital Pipeline
Mercury Switch
Zone Valve
Relief Valve
A
B
Pressure Reducing Regulator
Pipeline Pressure Gauge
A
B
Cylinder Bank A
Cylinder Bank B

CENTRAL MEDICAL GAS SUPPLY

In most hospitals, medical gases are supplied to various locations via a central piping system.

The medical gas source may consist of a cryostat, pressure vessels mounted on a trailer or cylinders manifolded together, depending on the type of gas and individual requirements.

The gas source described in this section is a combination of 2 (two) cylinder banks which must be adjusted manually. This type of manifold system is frequently used for emergency oxygen supply in conjunction with a cryostat. It may also be used as the primary supply source for nitrous oxide, nitrogen and air.

The gas source consists of 2 (two) banks of cylinders, which are connected parallel within each bank. The operating or pipeline pressure of each bank is controlled by a pressure reducing regulator. Zone valves allow for individual isolation of each bank from the piping system. Should a pressure reducing regulator malfunction, a relief valve will protect the piping system from excessive pressure by discharging the gas into the atmosphere. Pressure reductions below normal operating level (50 to 55 psi) may be caused by the depletion of cylinder gas or a leak in the piping system. An alarm is activated by a mercury switch to alert the consumer.

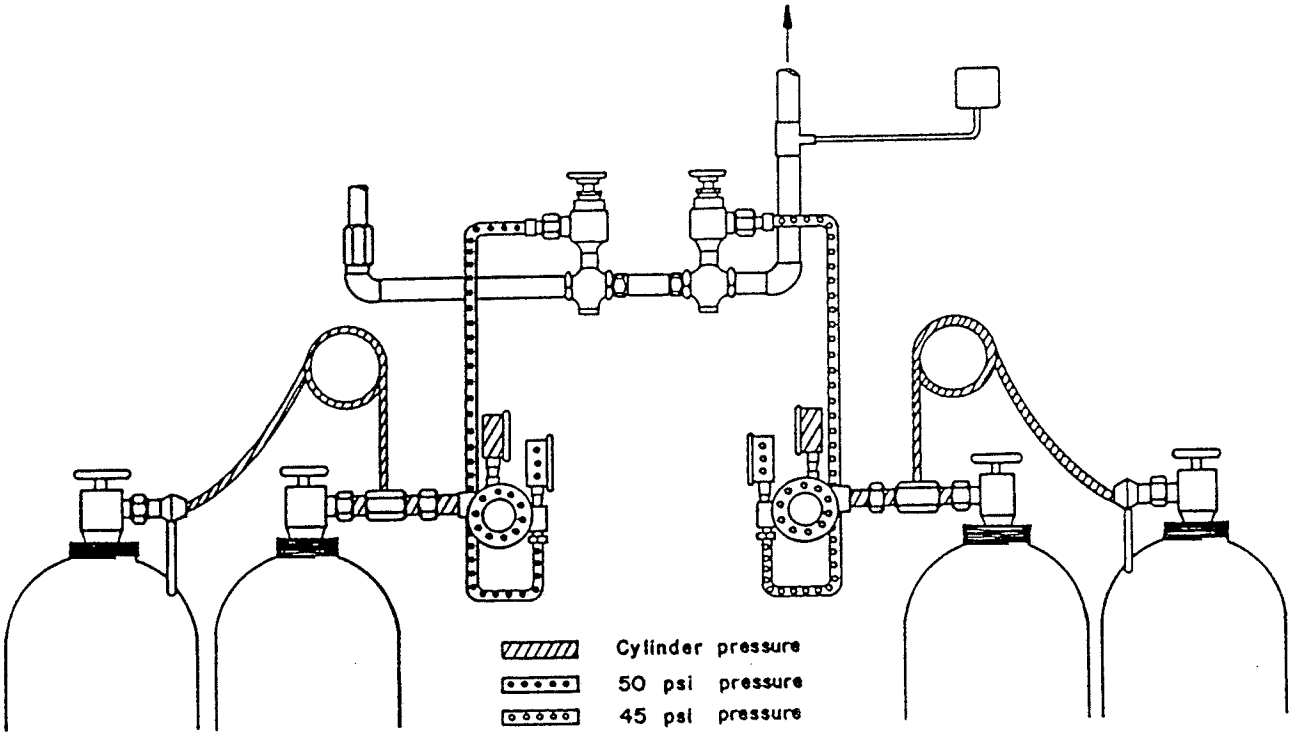
NOTE: It is imperative that the pipeline system is designed to accomodate maximum gas consumption without a pressure reduction below normal operating level.

For example: If in the operating room area the piping system is underrated (piping diameter is too small), the activation of the oxygen flush valve on an anesthesia machine may cause an excessive pressure drop. This may result in a noticable decrease of the oxygen flowrate and/or the cessation of pneumatically operated ventilators.

NOTE: The pipeline pressure must never drop more than 2 psi on any service station during peak consumption.

NOTE:: If pipeline pressure is set below the output pressure of the pressure reducing regulator in the anesthesia machine, gas will be drawn from the reserve cylinder instead of the pipeline system.

CYLINDER MANIFOLD



CYLINDER MANIFOLD

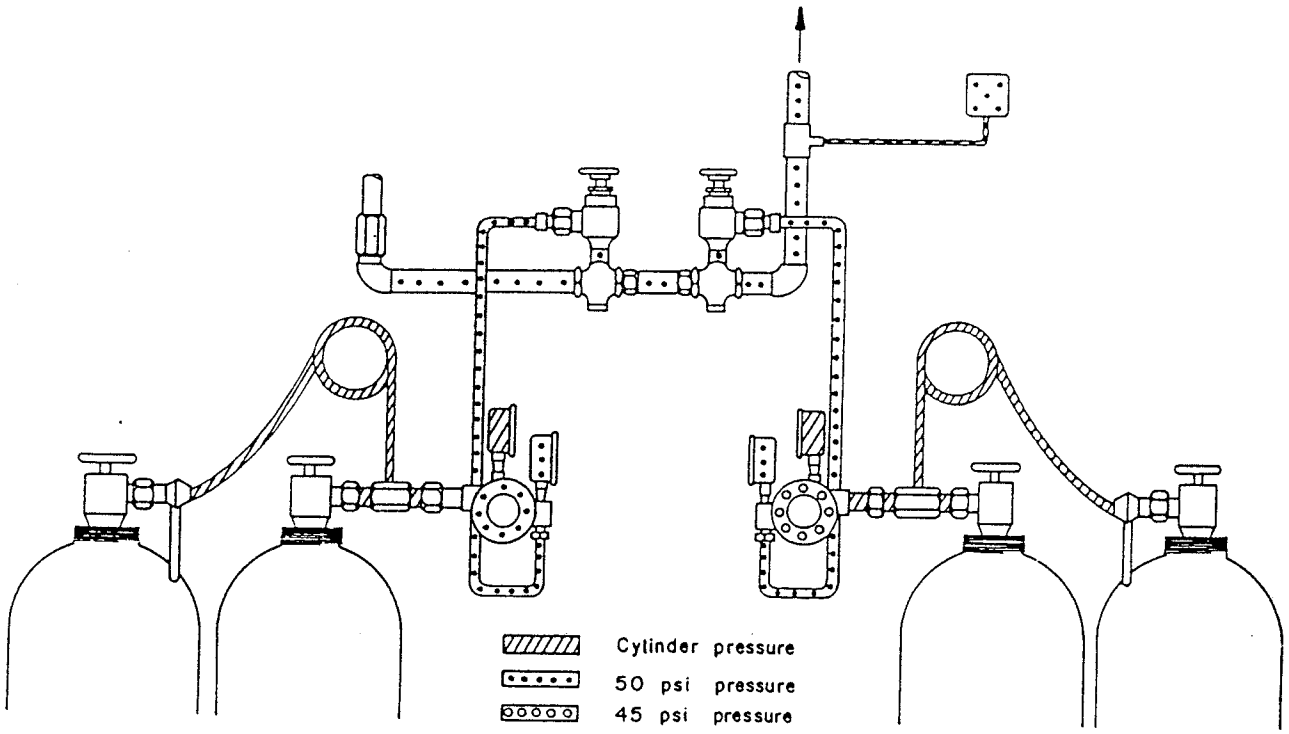
Both cylinder banks are activated. All cylinder valves are turned ON. The pressure reducing regulator (A) of the left cylinder bank (A) is set at 50 psi while the zone valve (A) is closed.

The pressure reducing regulator (B) of the right cylinder bank (B) is set at 45 psi. The corresponding zone valve (B) is closed.

The bank set at the higher pipeline pressure (50 psi) will serve as the **active** bank, while the bank set at the lower pipeline pressure (45 psi) will be the **stand-by** bank.

Gas cannot enter the hospital pipeline as long as both zone valves remain closed.

CYLINDER MANIFOLD



CYLINDER MANIFOLD

After the zone valve (A) of the left cylinder bank (A) is opened the pipeline system is charged with gas at 50 psi pressure.

When the zone valve (B) of the right cylinder bank (B) is opened, the pressure in the entire hospital piping system will be 50 psi pressure.

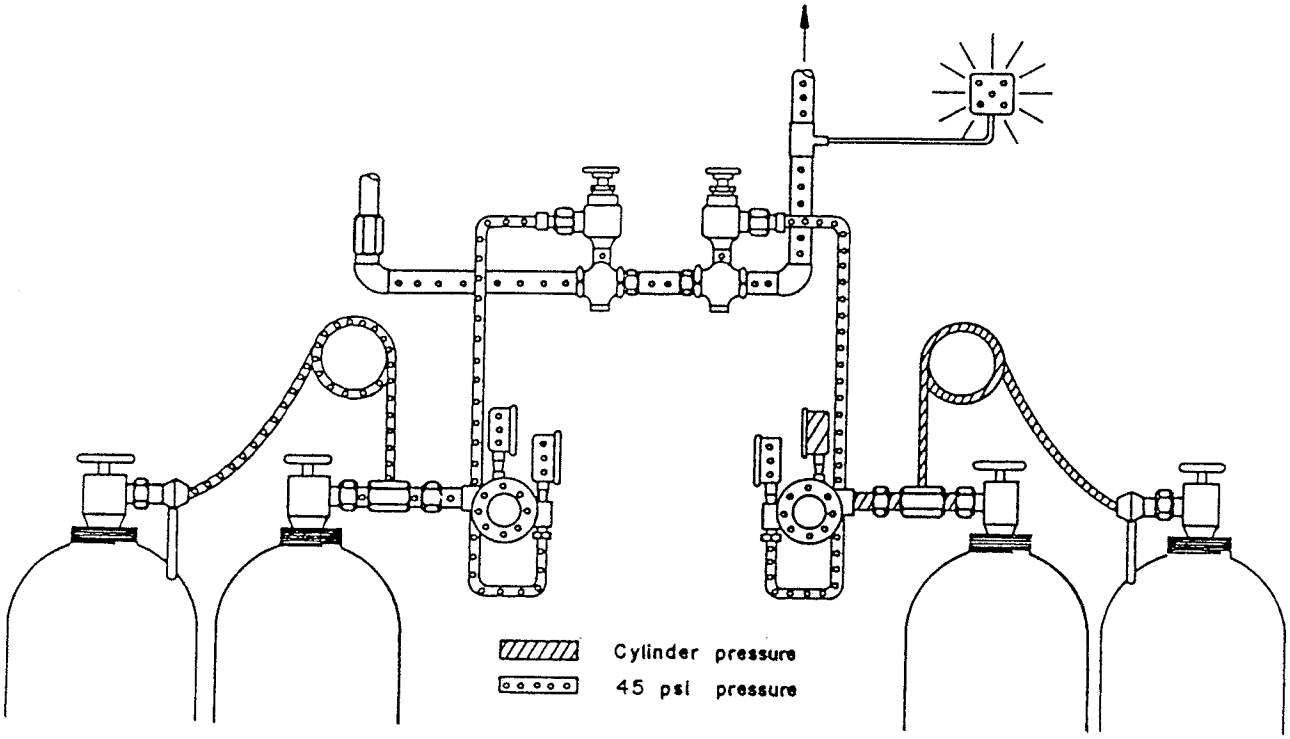
The pressure between the pressure reducing regulator (B) and the zone valve (B) of the stand-by bank (B) will also increase to 50 psi.

Both pipeline pressure gauges (A and B) will now read 50 psi pipeline pressure.

Gas is drawn from the left (active) cylinder bank (A), since it was adjusted to a higher pressure (50 psi) than the right (stand-by) cylinder bank (B) at 45 psi.

Gas will be drawn from the active bank (A) until the cylinder pressure falls to 45 psi.

CYLINDER MANIFOLD



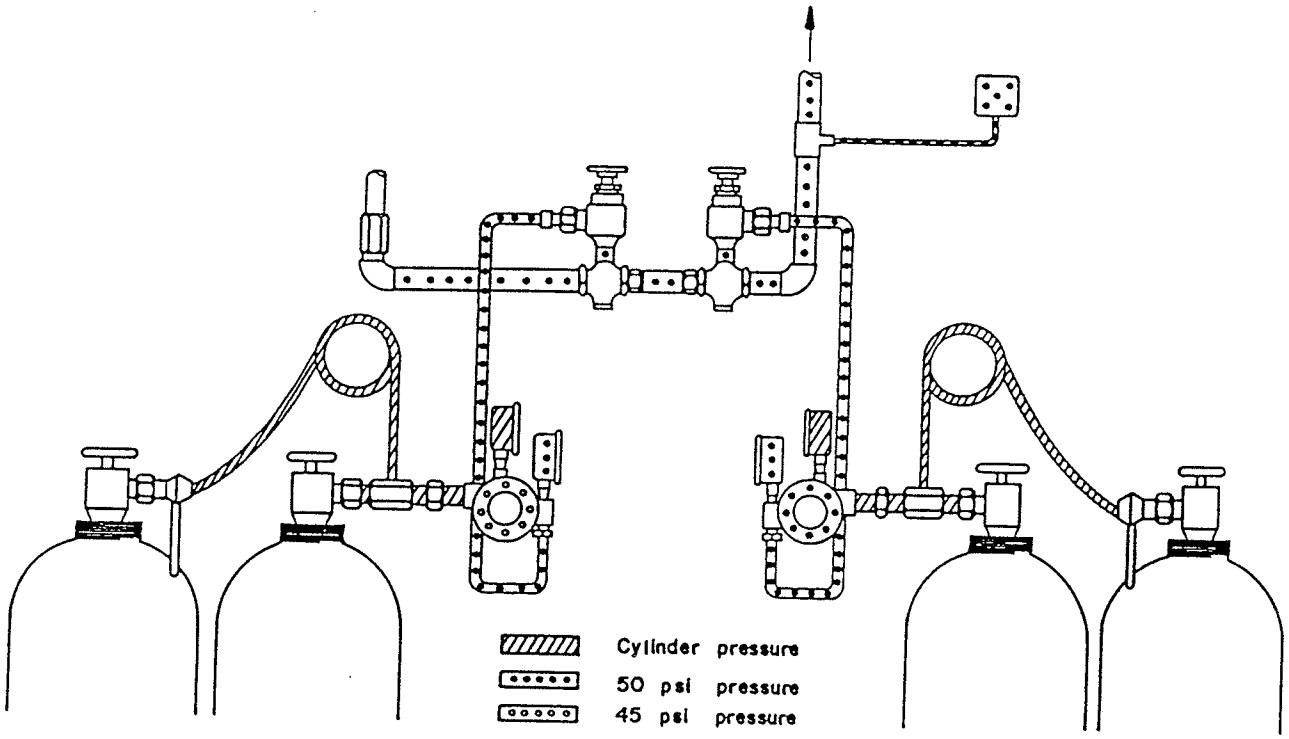
CYLINDER MANIFOLD

Once the pressure in the cylinders of the active cylinder bank (A) has dropped to 45 psi the low pressure alarm is activated and the stand-by bank (B) is supplying gas to the pipeline system at 45 psi. Gas is no longer drawn from the left bank (A).

NOTE: As the pipeline pressure gradually decreases from 50 psi to 45 psi, the anesthesiologist may notice a gradual decrease of gas flow on the respective flowmeter. This can be corrected by increasing the flowrate to the original setting.

NOTE: A pressure decrease in the oxygen pipeline system may also decrease gas flows of other gases if the oxygen failure protection device is effected by this pressure drop.

CYLINDER MANIFOLD



CYLINDER MANIFOLD

The empty cylinders of the left bank (A) must be replaced.

First, the left zone valve (A) must be closed. The hospital pipeline pressure can now be increased to normal operating level (50-55 psi) by adjusting the right pressure reducing regulator (B) of the right cylinder bank (B).

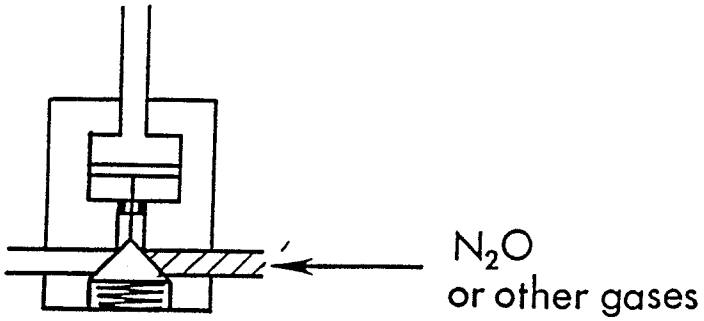
The cylinder valves of the left bank (A) must be closed before the cylinders can be removed. The left pressure reducing regulator (A) must be completely turned OFF. After the full cylinders are connected, the cylinder valves can be turned on and the left pressure reducing regulator (A) must be set to 45 psi hospital pipeline pressure. The left zone valve (A) can now be opened.

The left cylinder bank (A) now serves as the **stand-by** bank, while the right cylinder bank (B) becomes the active bank.

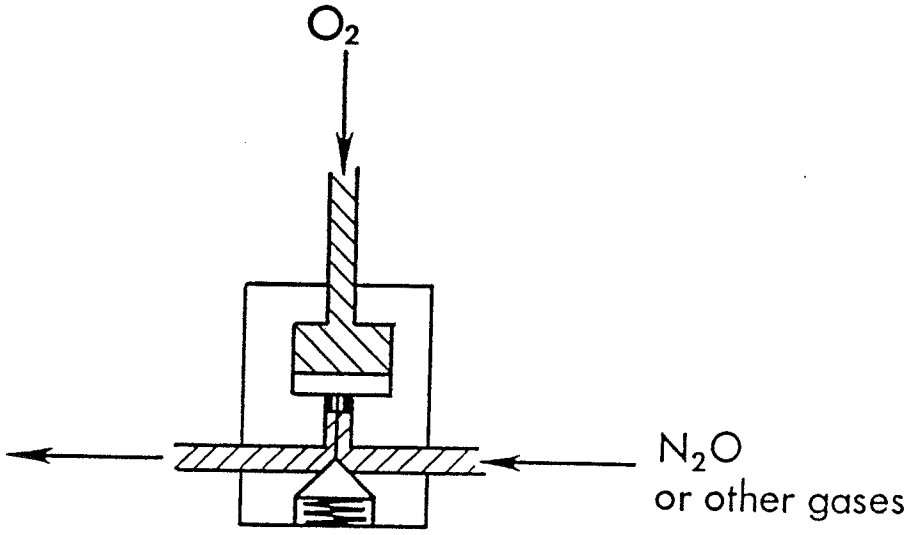
NOTE: As the pipeline pressure is increased again from 45 psi to 50 psi, the anesthesiologist will notice an increase of gas flow on the respective flowmeter. This can be corrected by decreasing the flowrate to the original setting.

OXYGEN FAILURE PROTECTION DEVICE

O.F.P. DEVICE



deactivated
(no O_2 pressure)



activated
(O_2 pressure)

O.F.P. DEVICE

The purpose of the Oxygen Failure Protection Device is to prevent the flow of gases other than oxygen in case of an oxygen supply failure. Without this device pure nitrous oxide could suddenly be administered during anesthesia, should the oxygen supply fail. Since pure nitrous oxide is a hypoxic gas and cannot sustain life, the consequences for the patient would be detrimental.

The O.F.P.D. consists of a seat/nozzle assembly which is connected to a spring loaded piston. In deactivated condition, the spring is expanded which forces the nozzle against the seat. No gas can flow through the device.

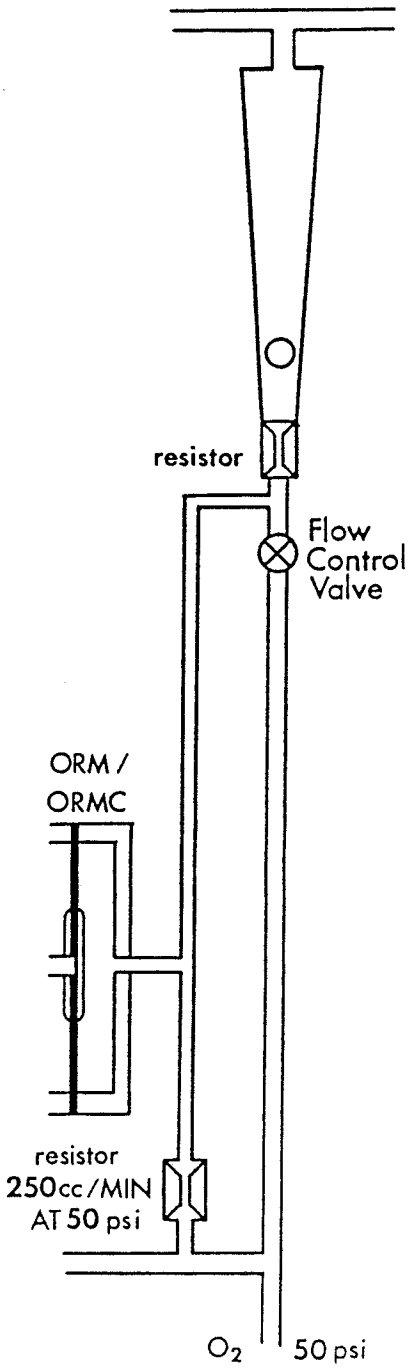
As oxygen pressure is building in the anesthesia system, oxygen pressure is also applied to the piston, which forces the nozzle away from the seat. Gas can now flow through the O.F.P.D.

The O.F.P.D. is designed to respond proportionally to oxygen pressure changes. If the oxygen pressure drops, the gases which are controlled by the device will drop approximately proportionally with the oxygen.

All gas systems such as nitrous oxide, air, carbon dioxide, helium or nitrogen contain O.F.P. Devices, which are activated by oxygen pressure. The oxygen system itself does not require an O.F.P.D.

MINIMUM OXYGEN FLOW

MINIMUM OXYGEN FLOW



MINIMUM OXYGEN FLOW

The minimum oxygen flow is a safety feature which is incorporated in all NAD Anesthesia Systems with a main ON/OFF switch. The minimum oxygen flow of approximately 250cc at 50 psi pipeline pressure prevents the administration of pure nitrous oxide.

A precalibrated resistor is inserted into a T-piece of the anesthesia machine oxygen supply system. The resistor decreases the gas flow. The reduced gas flow is injected upstream of the oxygen flow control valve, immediately below a second resistor.

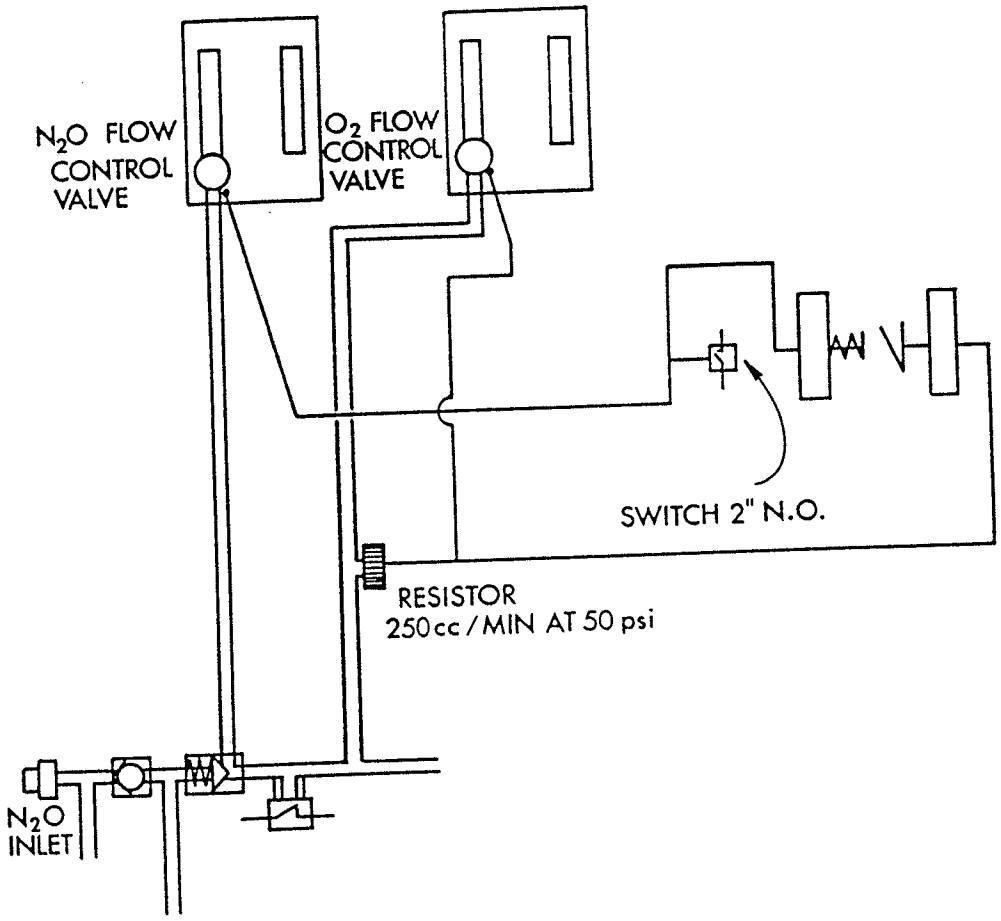
In by-passing the oxygen needle valve (flow control valve) a constant minimum oxygen flow is injected into the flowmeter tube.

When the needle valve is turned ON, the minimum flow will be overridden by the regular gas flow.

Closing the needle valve completely will therefore not eliminate the minimum oxygen flow.

OXYGEN RATIO MONITOR (O.R.M.)
AND
OXYGEN RATIO MONITOR CONTROLLER
(O.R.M.c.)

O.R.M


N_2O FLOW CONTROL VALVE
O_2 FLOW CONTROL VALVE
SWITCH 2" N.O.
RESISTOR
250cc / MIN AT 50 psi
N_2O INLET

O.R.M.

The Oxygen Ratio Monitor (O.R.M.) is a mechanical device which responds to pressure changes in the oxygen and the nitrous oxide gas supply systems.

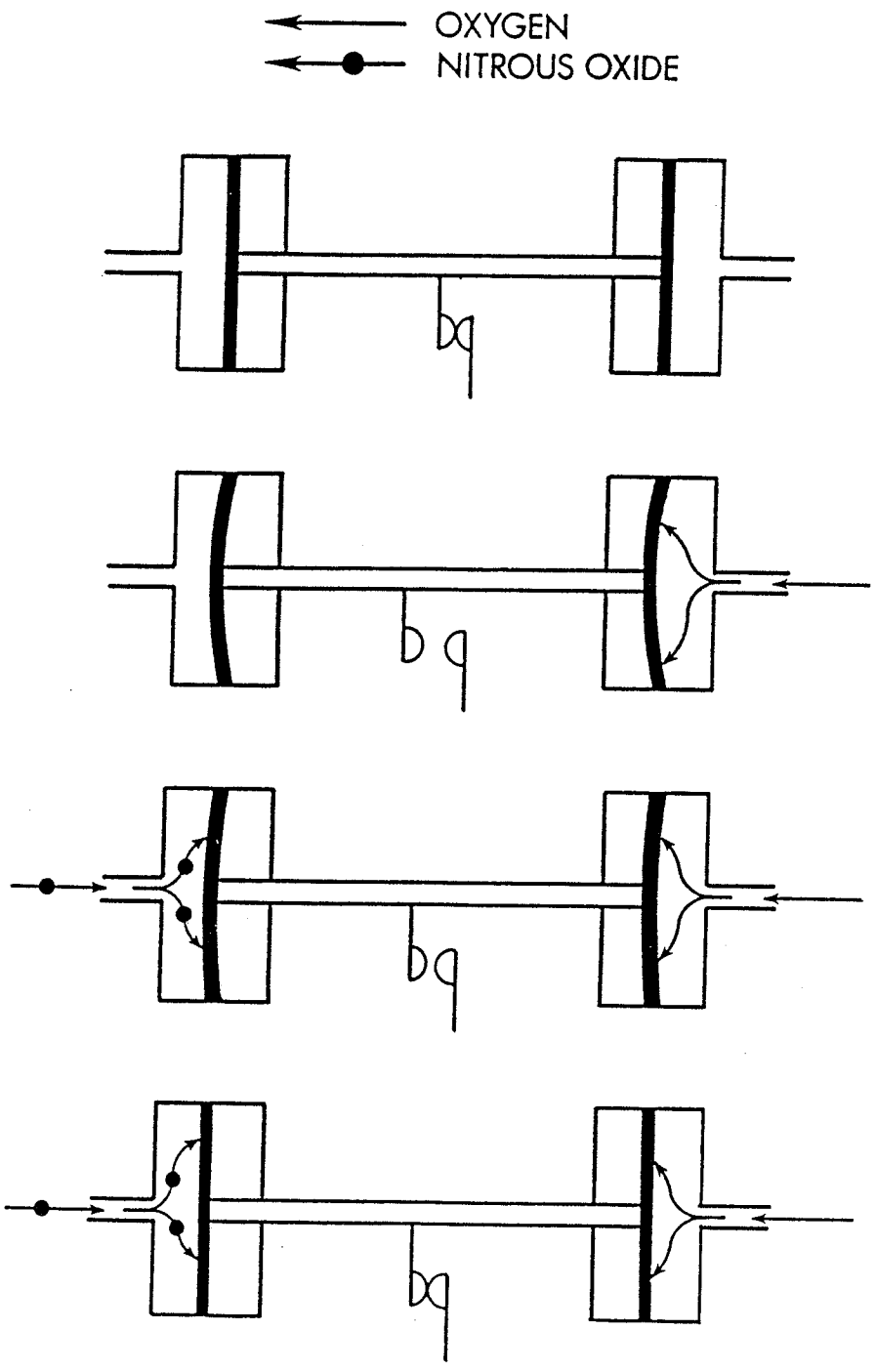
Specific resistors are located between the flow control valves and the fine flowtubes of both gases. Downstream of these resistors (between the flow control valve and the resistor) a back pressure is created which varies with the gas flow. This back pressure is directed into a chamber, which similar to a pressure reducing regulator, has a diaphragm. The diaphragms of the oxygen and nitrous oxide chambers are connected with each other via a movable shaft. When the oxygen flow control valve is turned ON, a back pressure is created and transfered to the oxygen chamber. The back pressure applies pressure on the diaphragm and forces the shaft towards the nitrous oxide chamber. The higher the oxygen flow, the higher the back pressure.

As the nitrous oxide flow is turned ON, pressure is created in the nitrous oxide chamber and the shaft is forced again towards the oxygen chamber.

As oxygen or nitrous oxide flows are changed. the pressure changes in both chambers will cause the shaft to move in either direction. Electric switch contacts which are mounted on the shaft will open and close depending on the direction the shaft is moving. When the contacts are closed an audio/visual alarm is activated. The alarm will indicate that the oxygen percentage of the combined oxygen and nitrous oxide flow has dropped below 30%. The threshold of the 30% oxygen concentration is determined by the value of the 2 (two) resistors.

The operator is able to override the alarm threshold and may administer oxygen concentrations of less than 30%. The audio portion of the alarm can be silenced.

NOTE: The O.R.M. is only functional when oxygen and nitrous oxide are administered. The addition of other medical gases or the substitution of nitrous oxide with another medical gas renders the O.R.M. ineffective.


OXYGEN
NITROUS OXIDE

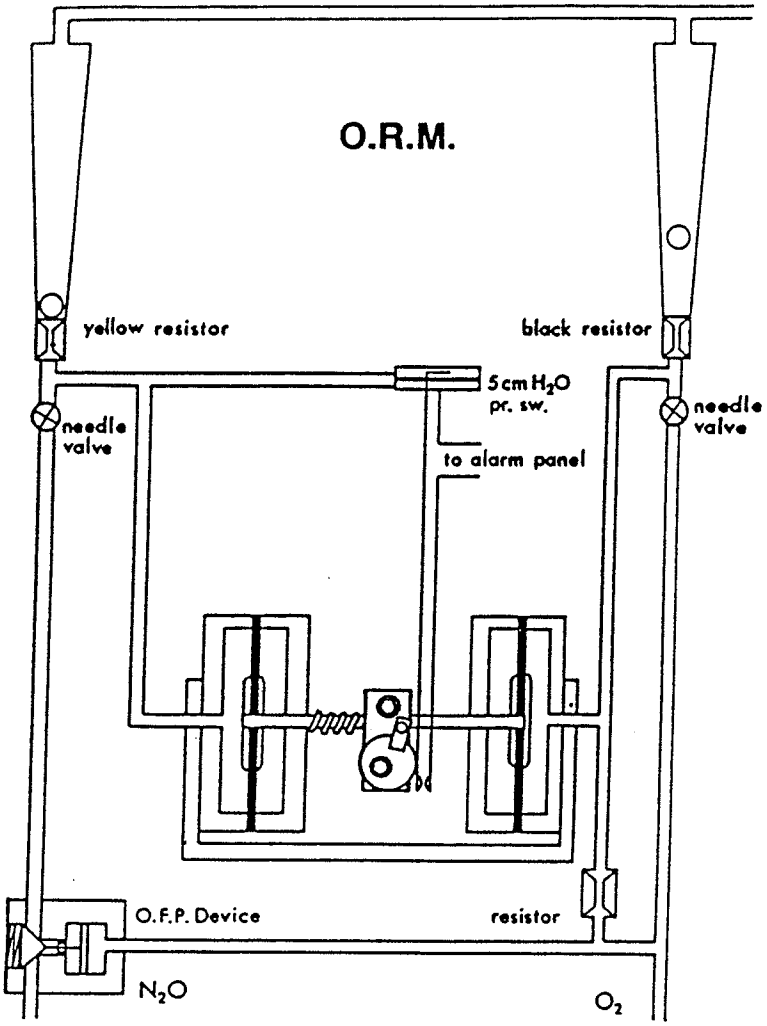
O.R.M.

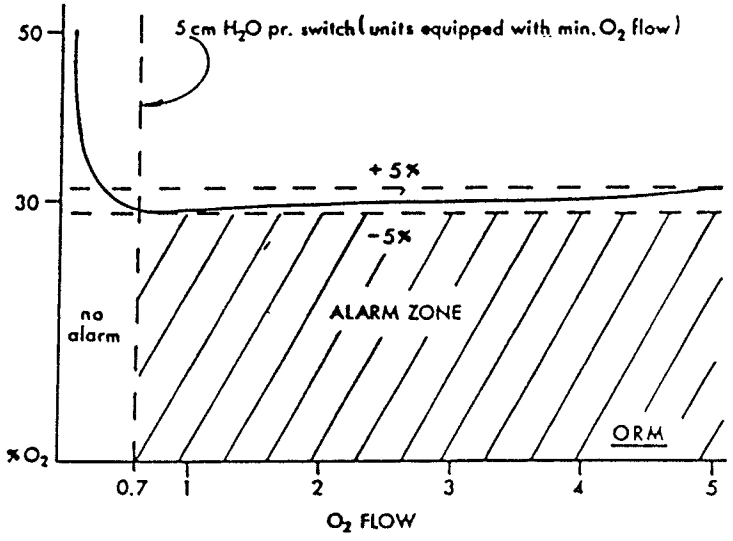
While the O.R.M. is in the deactivated position, the electric switch contacts are closed.

Oxygen enters the oxygen chamber and pressure build-up forces the diaphragm and shaft towards the nitrous oxide chamber. The switch contacts are open.

Nitrous oxide is entering the nitrous oxide chamber and a counter pressure (depending on the nitrous oxide flow adjustment) is forcing the diaphragms and shaft towards their normal position. The switch contacts are about to close.

A pressure equilibrium is reached (30% oxygen and 70% nitrous oxide concentration is administered). The switch contacts are closed and the alarm is activated. Further increase of the nitrous oxide flow will not change the alarm condition, but will decrease the oxygen concentration while increasing the nitrous oxide concentration.


O.R.M.
yellow resistor
black resistor
5 cm H_2O pr. sw.
needle valve
needle valve
to alarm panel
O.F.P. Device
resistor
N_2O
O_2


5 cm H_2O pr. switch (units equipped with min. O_2 flow)
50
30
+5%
-5%
no alarm
ALARM ZONE
ORM
% O_2
0.7
1
2
3
4
5
O_2 FLOW

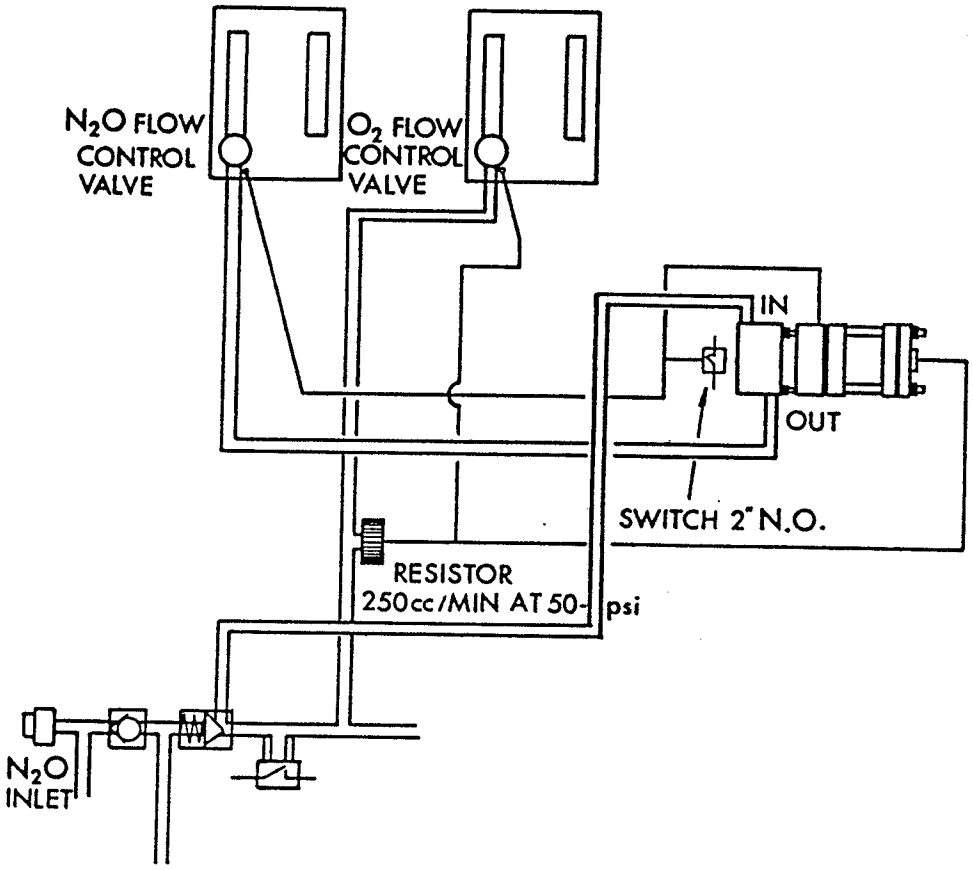
O.R.M.

When the main switch is turned ON (NARKOMED Anesthesia Machines which are equipped with such a switch) the medical gas system becomes functional. The oxygen pressure activates all O.F.P. Devices. The minimum oxygen gas flow is directed into the fine oxygen flowtube.

Since the minimum flow does not create a high enough back pressure in the oxygen chamber of the O.R.M., the electric switch contacts remain closed and an erroneous alarm condition exists. To eliminate this alarm condition a normally open 5cm H_2O pressure switch is placed in series with the electric switch contacts in the nitrous oxide circuit. A minimum of 5cm H_2O nitrous oxide back pressure will close this switch. Therefore, a nitrous oxide flow between 500 and 700cc must be administered before the O.R.M. is operational.

The alarm curve of the O.R.M. shows the correct adjustment to be 30 ± 5% oxygen concentration when oxygen flows above 700cc/min are administered. Below 700cc/min, the oxygen concentration increases and an alarm condition is not required.

O.R.M.c.


N_2O FLOW CONTROL VALVE
O_2 FLOW CONTROL VALVE
IN
OUT
SWITCH 2° N.O.
RESISTOR
250cc/MIN AT 50- psi
N_2O INLET

O.R.M.c.

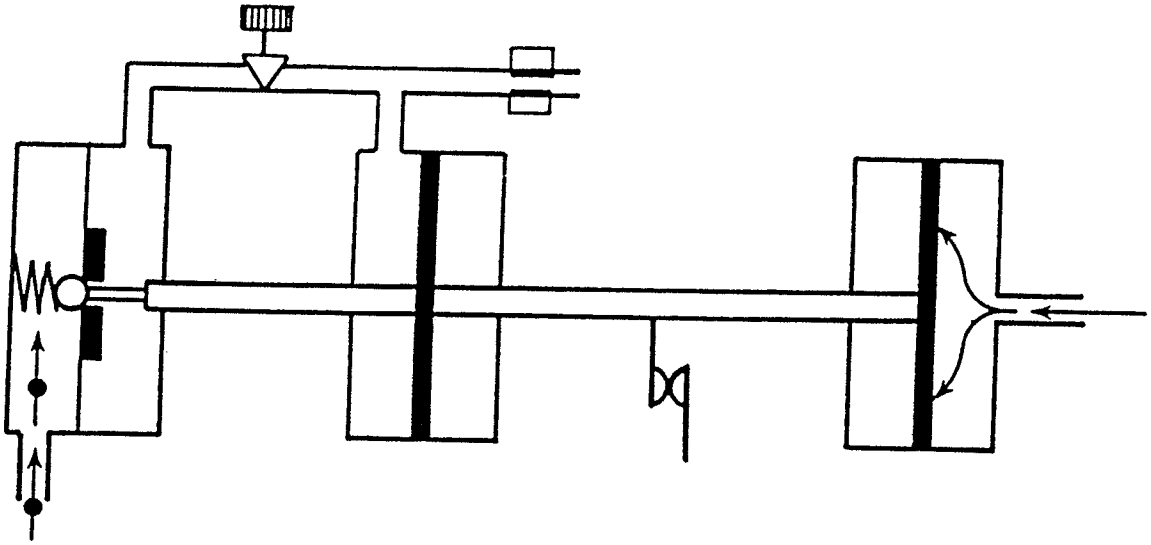
The basic design of the Oxygen Ratio Monitor Controller (O.R.M.c.) incorporates the features of the O.R.M. In addition, it prevents the administration of oxygen/nitrous oxide gas mixtures of less than 25% oxygen concentration.

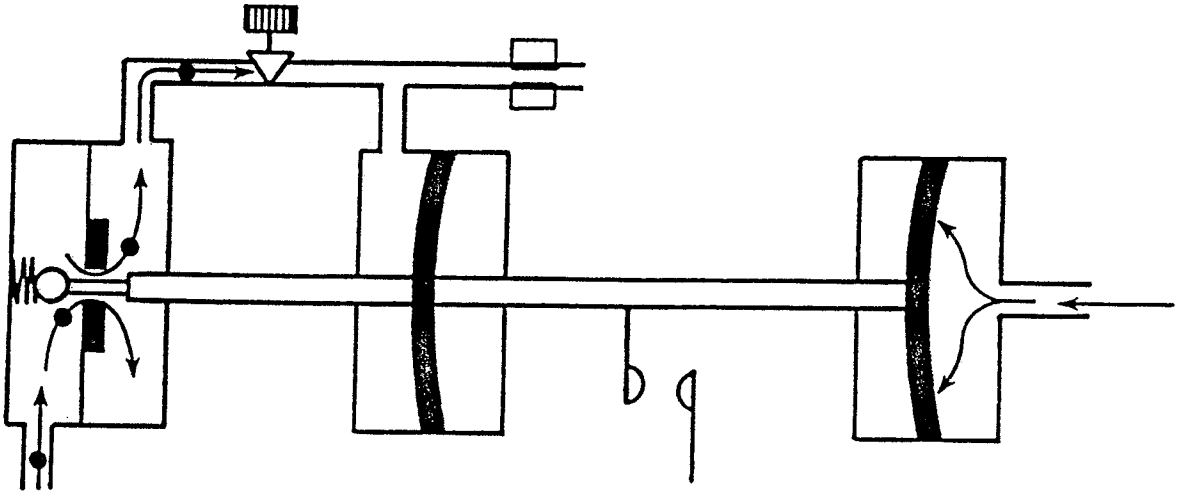
Contrary to the O.R.M., which allows the nitrous oxide to flow directly from the O.F.P. Device to the flow control valve, an additional flow control valve is located between these 2 (two) points. This valve is directly controlled by the O.R.M. section of the O.R.M.c. The shaft is extended beyond the nitrous oxide diaphragm into the valve assembly. As the diaphragm and shaft are moving, the valve assembly opens to a greater or lesser extend.

If the oxygen pressure is proportionally higher than the nitrous oxide pressure, the valve opens to a larger degree allowing more nitrous oxide to flow. As the nitrous oxide flow is manually increased and the nitrous oxide pressure forces the shaft towards the oxygen chamber, the valve opening becomes more restrictive and limits the nitrous oxide flow to the flowmeter.

The O.R.M.c. is designed to prevent the administration of oxygen/nitrous oxide flows of less than 25% oxygen concentration. An audio/visual alarm will warn the operator when gas flows are selected which approach this low oxygen concentration. It will not be possible to override the alarm threshold. To eliminate the alarm condition the oxygen flow must be increased or the nitrous oxide flow decreased. If by mistake the oxygen flow should be decreased during an alarm condition, the nitrous oxide flow will automatically decrease so that an oxygen concentration of at least 25% is maintained.

NOTE: The O.R.M.c. is only functional when oxygen and nitrous oxide are administered. The addition of other medical gases or the substitution of nitrous oxide with another medical gas renders the O.R.M.c. ineffective.





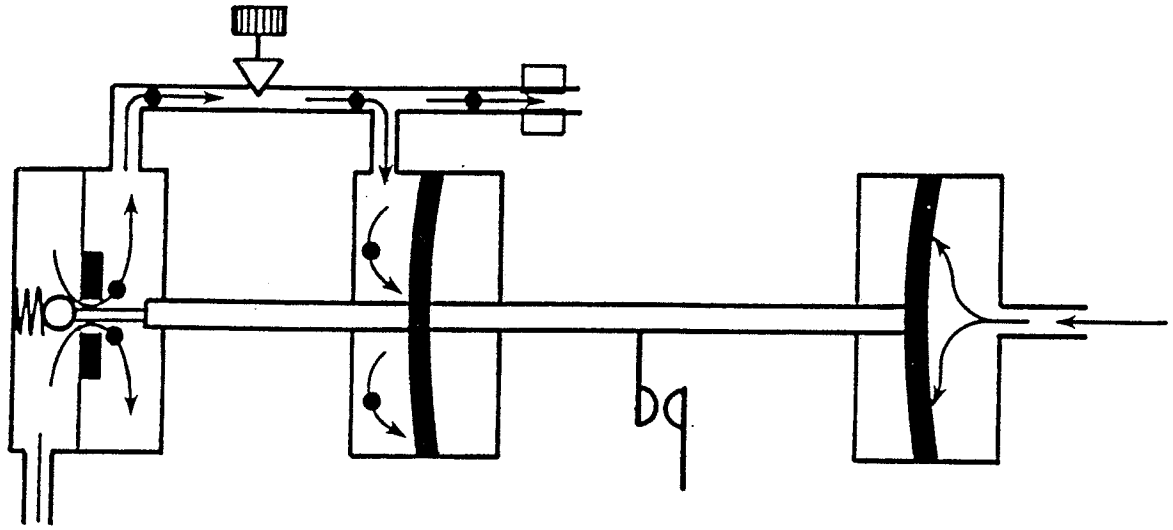
OXYGEN

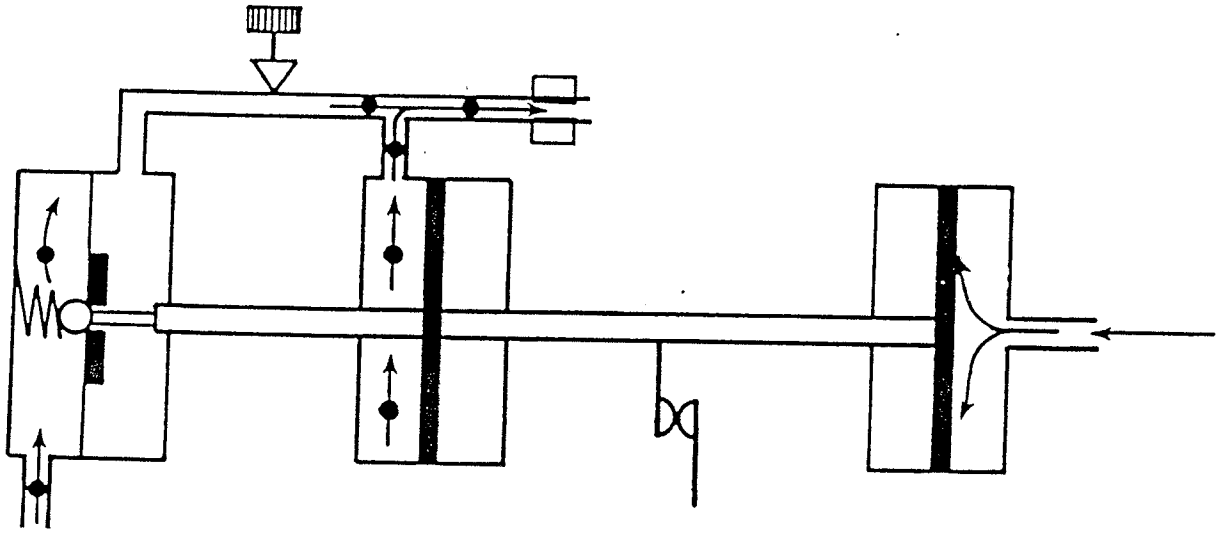
NITROUS OXIDE

O.R.M.c.

After the main switch is turned ON, the oxygen minimum flow is established. Nitrous oxide enters the O.R.M.c. flow valve chamber, but the valve remains closed. The electric switch contacts remain closed since the minimum oxygen flow does not apply enough back pressure to move the diaphragm and shaft.

When the oxygen flow is increased, the back pressure forces the diaphragms and shaft towards the O.R.M.c. valve chamber. The valve begins to open and allows nitrous oxide to flow towards the nitrous oxide flow control valve. This valve is still closed and nitrous oxide cannot enter the fine flowtube.





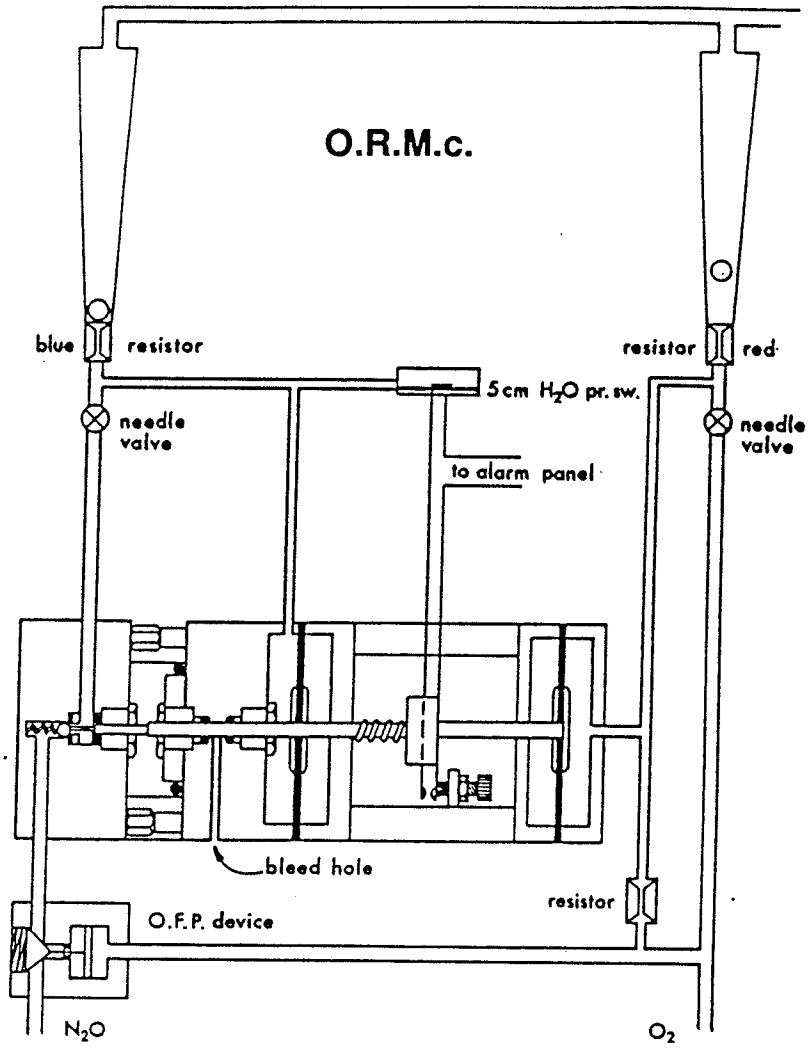
OXYGEN

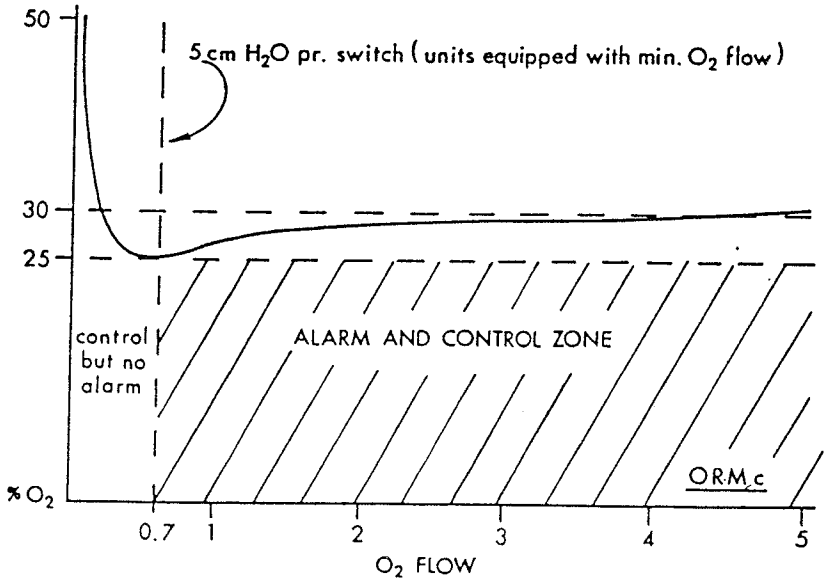
NITROUS OXIDE

O.R.M.c.

When the nitrous oxide flow control valve is gradually turned ON, nitrous oxide is administered to the patient in addition to oxygen. The back pressure between the needle valve and the resistor applies a counter pressure on the diaphragm of the nitrous oxide chamber. This pressure begins to force the shaft towards the oxygen chamber which results in a greater restriction of gas flow through the O.R.M.c. flow valve. Therefore, the nitrous oxide gas flow through the flowmeter becomes more restrictive. The electric switch contacts are about to touch and indicate an alarm condition.

The oxygen flow control valve is turned OFF and only the minimum oxygen flow is remaining. Although the nitrous oxide flow control valve is wide open the gas flow is interrupted by the O.R.M.c. valve and the remaining nitrous oxide is depleted.


O.R.M.c.
blue
resistor
resistor
red
5cm H_2O pr. sw.
needle valve
needle valve
to alarm panel
bleed hole
resistor
O.F.P. device
N_2O
O_2


50
30
25
5cm H_2O pr. switch (units equipped with min. O_2 flow)
control but no alarm
ALARM AND CONTROL ZONE
ORMc
% O_2
0.7
1
2
3
4
5
O_2 FLOW

O.R.M.c.

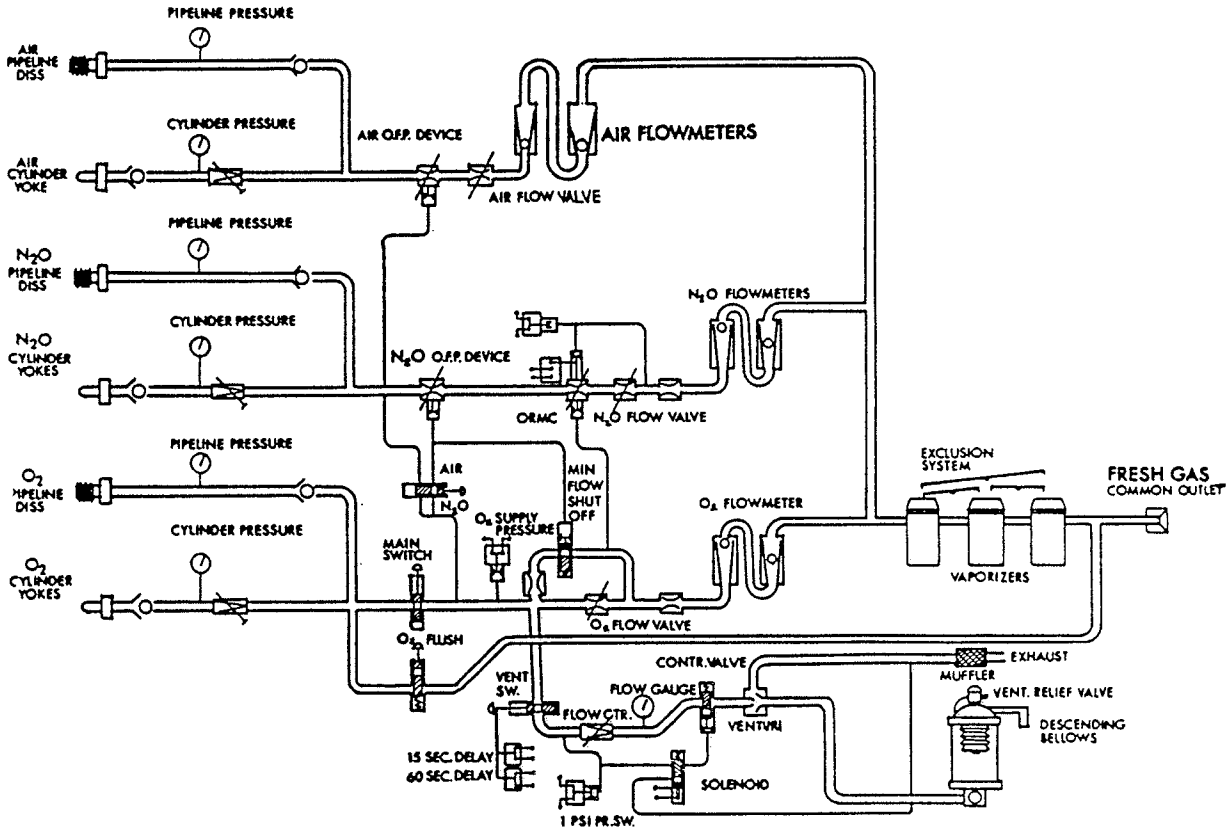
All parameters which were described for the O.R.M. apply for the O.R.M.c. with 2 (two) exceptions:

1. The nitrous oxide flow is directed through the O.R.M.c. flow valve where the gas to the nitrous oxide flowtube is automatically limited by the O.R.M.c.
2. No oxygen/nitrous oxide gas flows can be administered which contains less than 25% oxygen concentrations. The operator cannot override the alarm condition.

The alarm curve of the O.R.M.c. shows that oxygen concentrations are 25% in the low flow range and increase to approximately 30% oxygen in higher flow ranges. The 5cm H_2O pressure switch prevents the activation of the audio/visual alarm in oxygen flow ranges below 700cc/min without effecting the control function of the O.R.M.c.

GAS PIPING SYSTEM OF NARKOMED 2A

PIPING DIAGRAM - NM2A



PIPING DIAGRAM - NM2A

All NAD Anesthesia Machines are designed to use oxygen as the primary gas. All other gases can only be administered after oxygen supply pressure is available.

OXYGEN SUPPLY FROM CENTRAL MEDICAL GAS SYSTEM

Oxygen enters the anesthesia machine through the DISS inlet. The cylinder regulator and check valve prevent reverse gas flow through the yoke. The same principle applies also for all other gases.

OXYGEN SUPPLY FROM RESERVE CYLINDER

Oxygen enters the anesthesia machine through the yoke assembly. The cylinder pressure is reduced in the regulator. The pipeline check valve prevents reverse gas flow through the DISS inlet. The same principle applies also for all other gases.

BASIC PRINCIPLE OF PIPING SYSTEM

Although pipeline and cylinder pressure are indicated on the appropriate pressure gauges, gas flows cannot be activated until the main switch is turned ON.

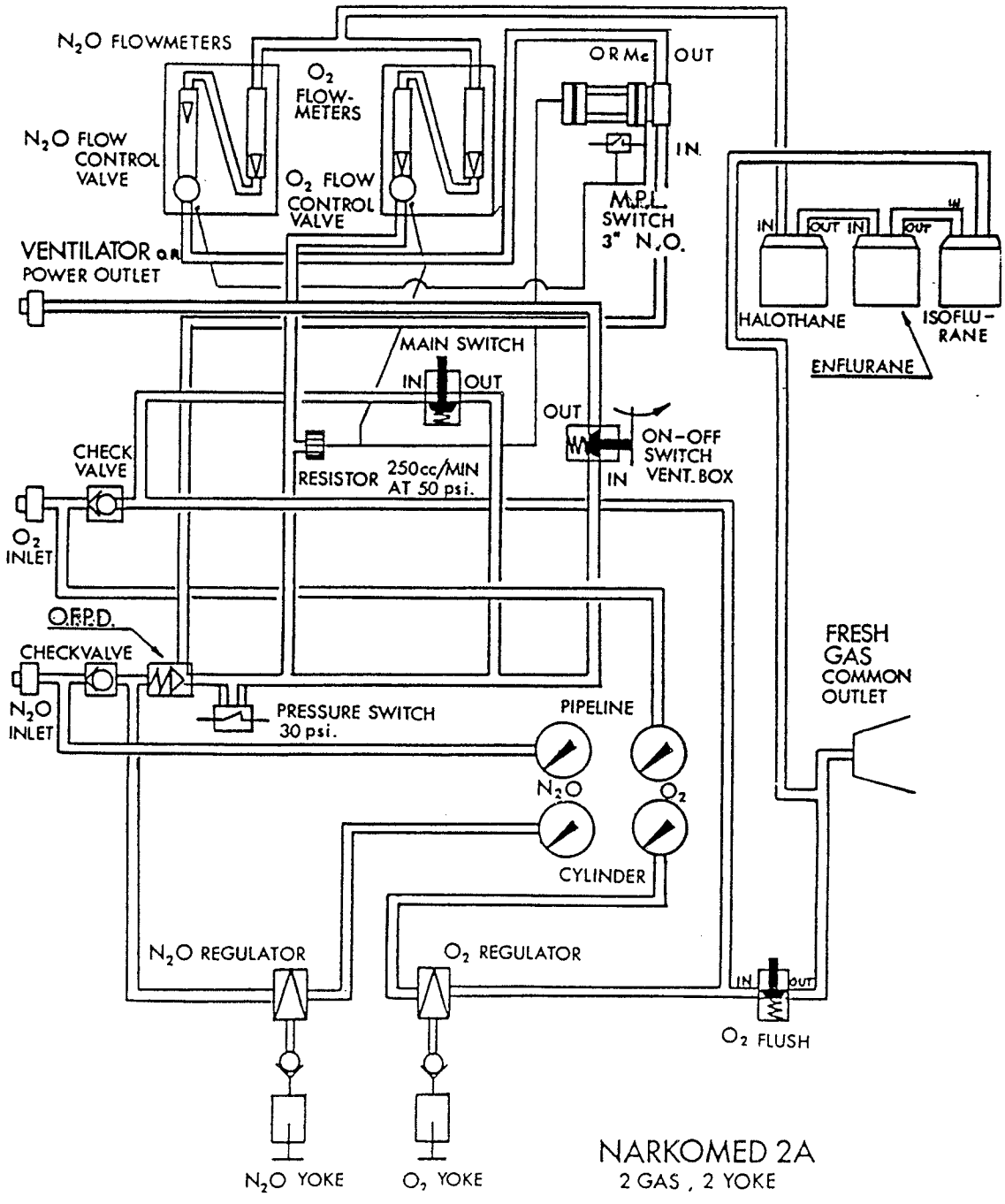
The exception is the oxygen flush, which by-passes the anesthesia system and can be activated, as long as oxygen pressure is available.

After the main switch is turned ON, oxygen pressure will build in the remaining oxygen system. If the N_2O/Air selector switch is set to the N_2O position, the minimum oxygen flow will be noticed and the oxygen supply pressure alarm switch will be deactivated. The nitrous oxide O.F.P.D. will also be activated, which will allow the administration of oxygen/nitrous oxide mixtures. In this condition, the O.R.M.c. is functional.

As long as the main switch remains turned ON, oxygen supply pressure is available for the operation of the anesthesia ventilator.

The oxygen/nitrous oxide gas mixture is directed to the vaporizers. Depending on which vaporizer is chosen for anesthesia, the gas mixture carries the appropriate vapor to the fresh gas (common) outlet and from there to the absorber system.

NARKOMED 2A - 2 GAS, 2 YOKE



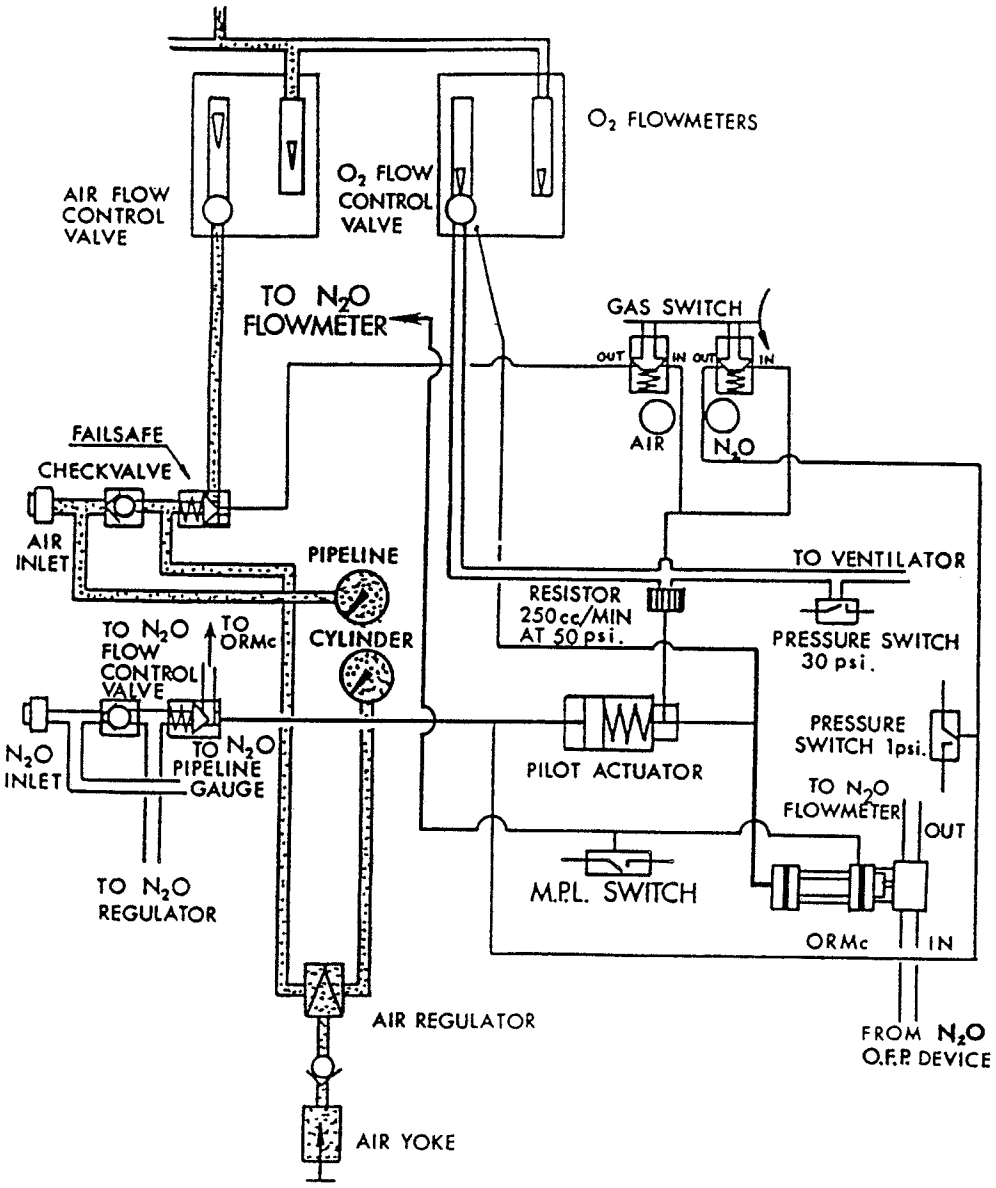
NARKOMED 2A - 2 GAS, 2 YOKE

This schematic shows a NARKOMED 2A gas piping system which employs only oxygen and nitrous oxide (no air).

NARKOMED 2A anesthesia machines which are not equipped with a NAD anesthesia ventilator, are supplied with a ventilator ON/OFF switch. This switch activates oxygen gas supply at 50 psi pressure to a power outlet and also activates the minimum ventilation alarm. The power outlet can be used to operate any anesthesia ventilator which requires 50 psi oxygen pressure.

NOTE: Double lines indicate 1/4" copper tubing while straight lines indicate 3/16" plastic tubing.

AIR ATTACHMENT - DISS/YOKE



AIR ATTACHMENT - DISS/YOKE

The DISS/Yoke system of anesthesia machines equipped with air employs the same principle as oxygen and nitrous oxide. These machines are also equipped with a N_2O/Air selector switch (gas switch). In the N_2O position, oxygen **with** minimum oxygen flow and nitrous oxide can be administered (no air). In the Air position, oxygen **without** minimum flow and Air can be administered (no N_2O).

NOTE: Double lines indicate 1/4" copper tubing while straight lines indicate 3/16" plastic tubing.

N_2O/AIR SELECTOR SWITCH (GAS SWITCH) IN N_2O POSITION

Oxygen at 50 psi pressure is directed through the N_2O section of the selector switch. It passes a 1 psi pressure switch, which becomes activated. This switch is located in series with the O.R.M.c. electronic circuit and must be closed to indicate an oxygen/nitrous oxide ratio alarm condition. The oxygen line continues and is divided into 2 (two) directions. One is connected to the nitrous oxide O.F.P.D., while the other activates a pilot actuator. In activated condition, this unit is open and allows the minimum oxygen flow to enter the oxygen fine flowtube. The O.R.M.c. is also functional since pressure feed back from the O_2 and N_2O flowmeters are available and the 1 psi switch is closed.

N_2O/AIR SELECTOR SWITCH (GAS SWITCH) IN AIR POSITION

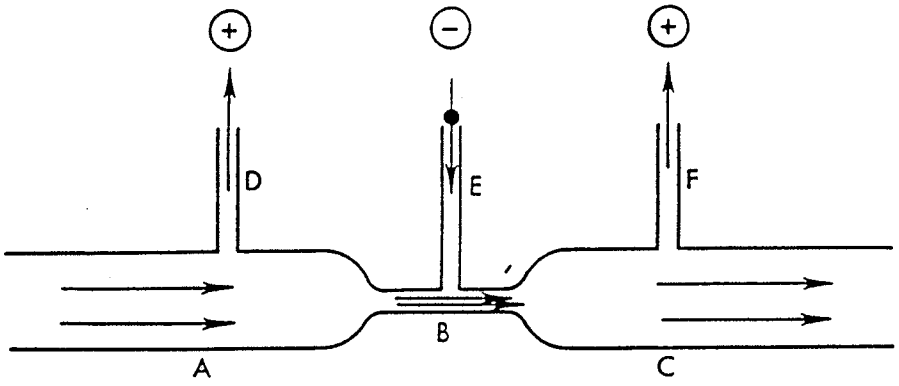
Oxygen at 50 psi pressure is directed through the Air section of the selector switch. It continues from the switch and activates the Air O.F.P.D. Since oxygen pressure is no longer supplied to the 1 psi pressure switch, the electronic circuit of the O.R.M.c. alarm function remains open and eliminates the O.R.M.c. as a safety device while Air is in use.

No oxygen pressure is supplied to the nitrous oxide O.F.P.D. and the pilot actuator. Neither can nitrous oxide be used, nor is the minimum oxygen flow available since the pilot actuator is deactivated.

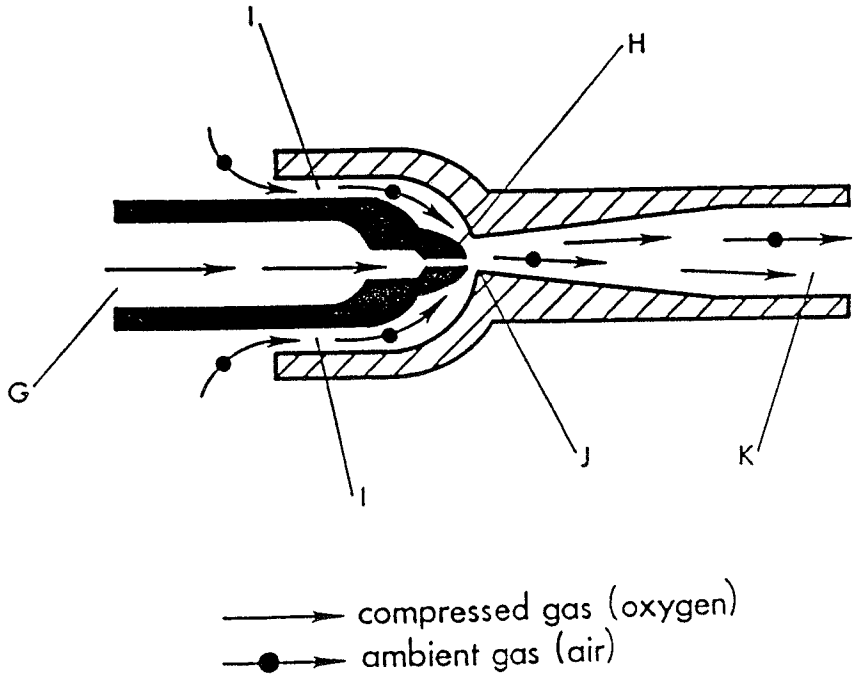
Tab 1

VENTURI

VENTURI EFFECT



INJECTOR



VENTURI EFFECT

A fluid or gas is flowing through a long, large bore tube with a constriction (B) in the center. The constriction is smooth, so the flow remains laminar. While the flow rate in the larger part of the tube (A) and (C) is the same, the flow rate in the smaller part of the tube (B) is increased. The pressure in part (A) is converted into speed in constriction (B). Therefore, the pressure in constriction (B) is decreased and will even drop below atmospheric pressure. Then the pressure is measured at points D,E and F, the pressure will be positive (above atmosphere) at points D and F, and negative (below atmosphere) at point E. This phenomenon is called Venturi Effect.

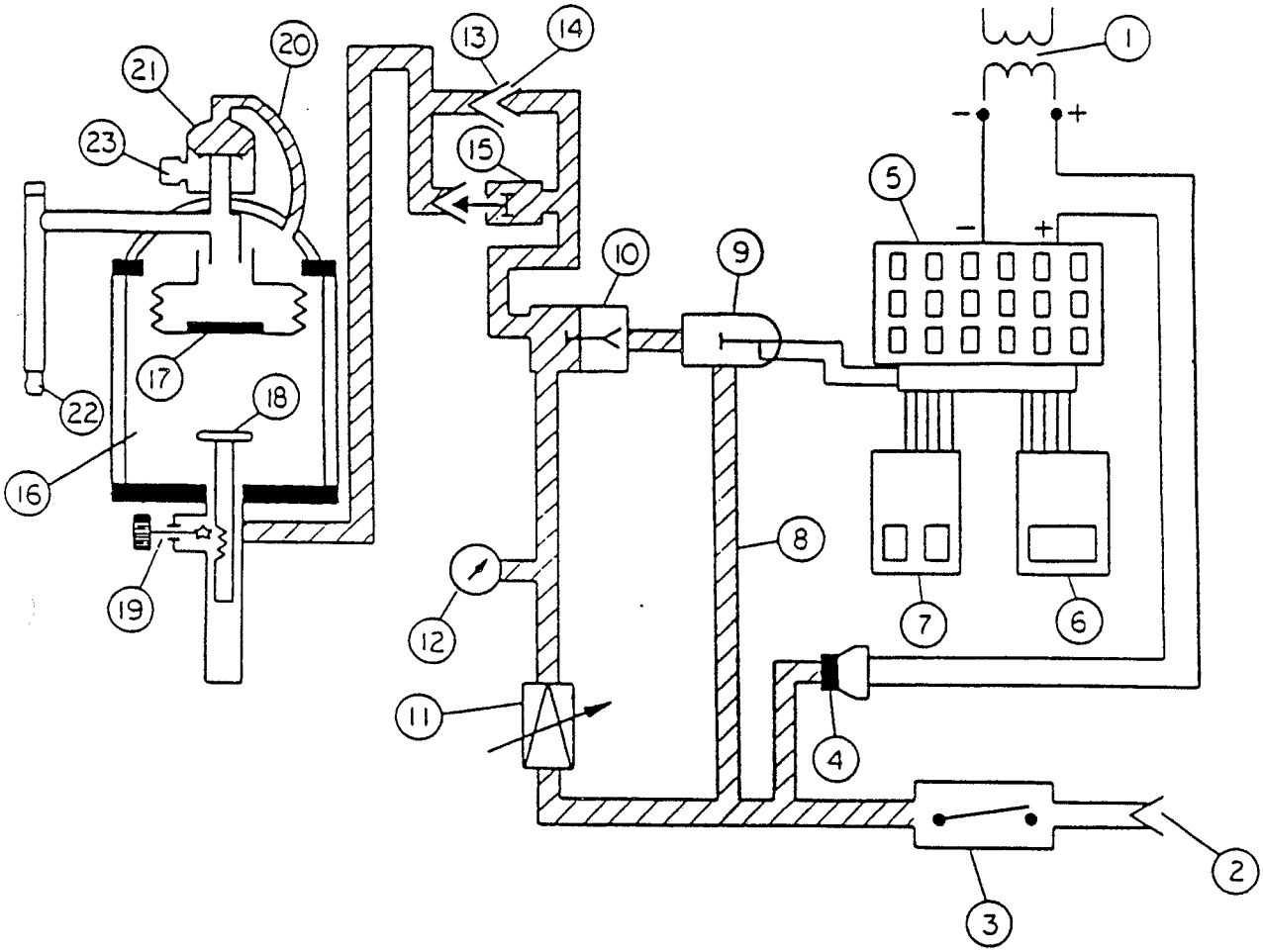
INJECTOR

There are many applications for the venturi effect. The NAD anesthesia ventilator uses the venturi effect to increase the gas flow, respectively gas volume into the bellows canister. Although commonly called venturi, the device is actually an injector.

The injector (venturi) consists of the compressed gas tube (G), a jet (H), entrainment port (I), throat (J) and diffuser (K).

As the compressed gas is forced at high speed through the jet and throat, which resembles the constriction, a sub-atmospheric pressure is created in the entrainment port. This results in ambient air being added to the compressed gas source which consequently are combined in the diffuser. The result is the availability of a considerably larger gas volume than the original compressed gas source could have supplied.

NAD ANESTHESIA VENTILATOR AV-E


1
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13
14
15
16
17
18
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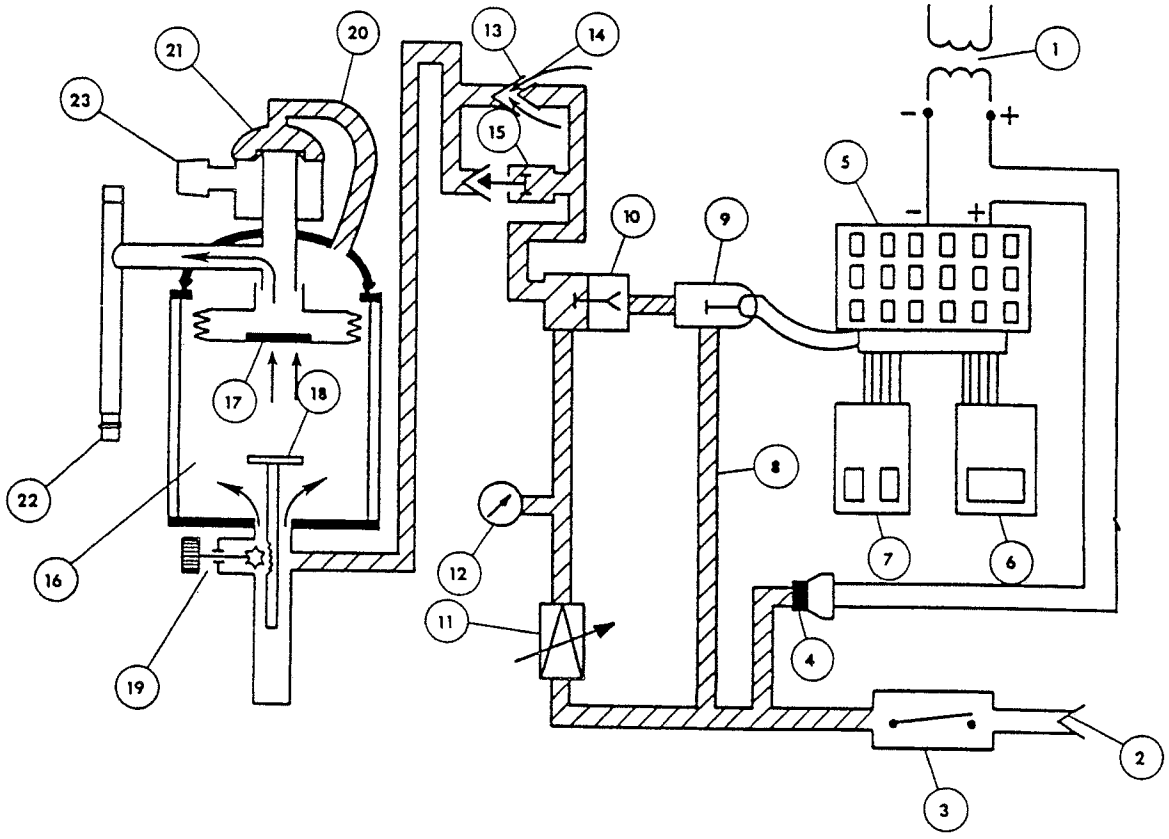
20
21
22
23
- +
- +

NAD ANESTHESIA VENTILATOR AV-E
LEGEND

1. Electric power supply (117 VAC)
2. Gas supply - Oxygen (50 psi)
3. Ventilator ON/OFF switch
4. Electrical supply ON/OFF switch (1 psi pressure switch)
5. AV-E - P.C. Board
6. I:E ratio control
7. Frequency control
8. Solenoid pilot pressure line
9. Solenoid valve
10. Control valve
11. Flow regulator
12. Flow indicator gauge
13. Venturi
14. Venturi entrainment port
15. Pilot actuator
16. Bellows chamber
17. Bellows
18. Tidal Volume adjustment plate
19. Tidal Volume control
20. Relief valve pilot line
21. Ventilator relief valve
22. Patient breathing system connector
23. Waste gas scavenging system connector

NOTE: Oxygen supply pressure and electric power must be supplied to operate the AV-E

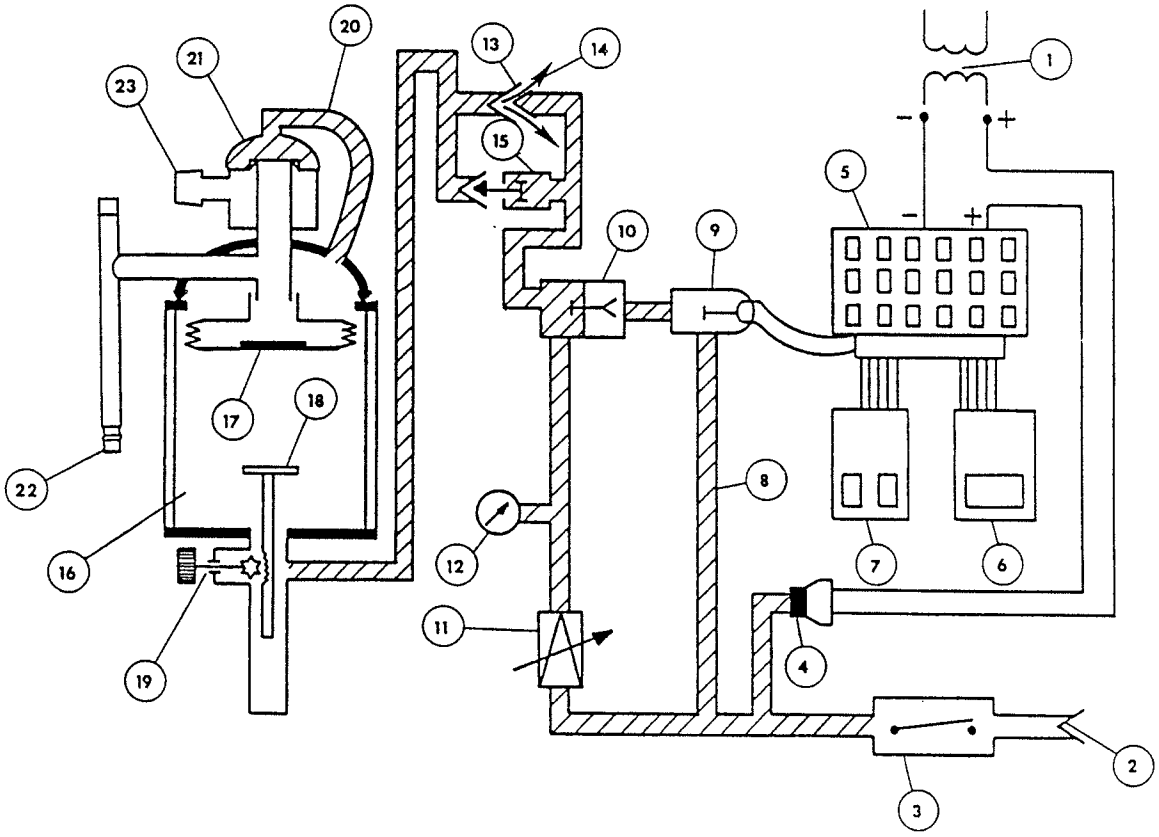
INSPIRATORY FLOW TIME



INSPIRATORY FLOW TIME

After ventilator ON/OFF switch (3) is turned ON, gas pressure is supplied to 1 psi switch (4), which is activated and supplies the electronic circuit with electric power. Flow regulator (11) can now be adjusted to the desired inspiratory flow rate. Frequency (7) and I:E ratio (6) controls must be adjusted as desired. Solenoid valve (9) receives an electric signal from AV-E P.C. Board (5). This electric signal will remain during the entire inspiration and activates the solenoid valve (9). Gas at 50 psi pressure can now pass through solenoid valve (9) and activate control valve (10). This allows the preset gas flow from flow regulator (11) to pass through the control valve (10) to venturi (13). The preset inspiratory flow rate can be monitored on flow indicator gauge (12). Back pressure from venturi (13) is directed to pilot actuator (15) which is closed. Ambient gas is entrained by venturi (13) through entrainment port (14). The combined gas is forced into bellows chamber (16). As pressure develops in bellows chamber (16) the bellows (17) rise and force air into the patient's lungs through patient breathing connector (22). Gas pressure is also supplied via the pilot line (20) from bellows chamber (16) to ventilator relief valve (21). This valve, which replaces the APL valve of the manual breathing circuit remains closed as long as bellows chamber (16) contains pressure.

INSPIRATORY PAUSE TIME

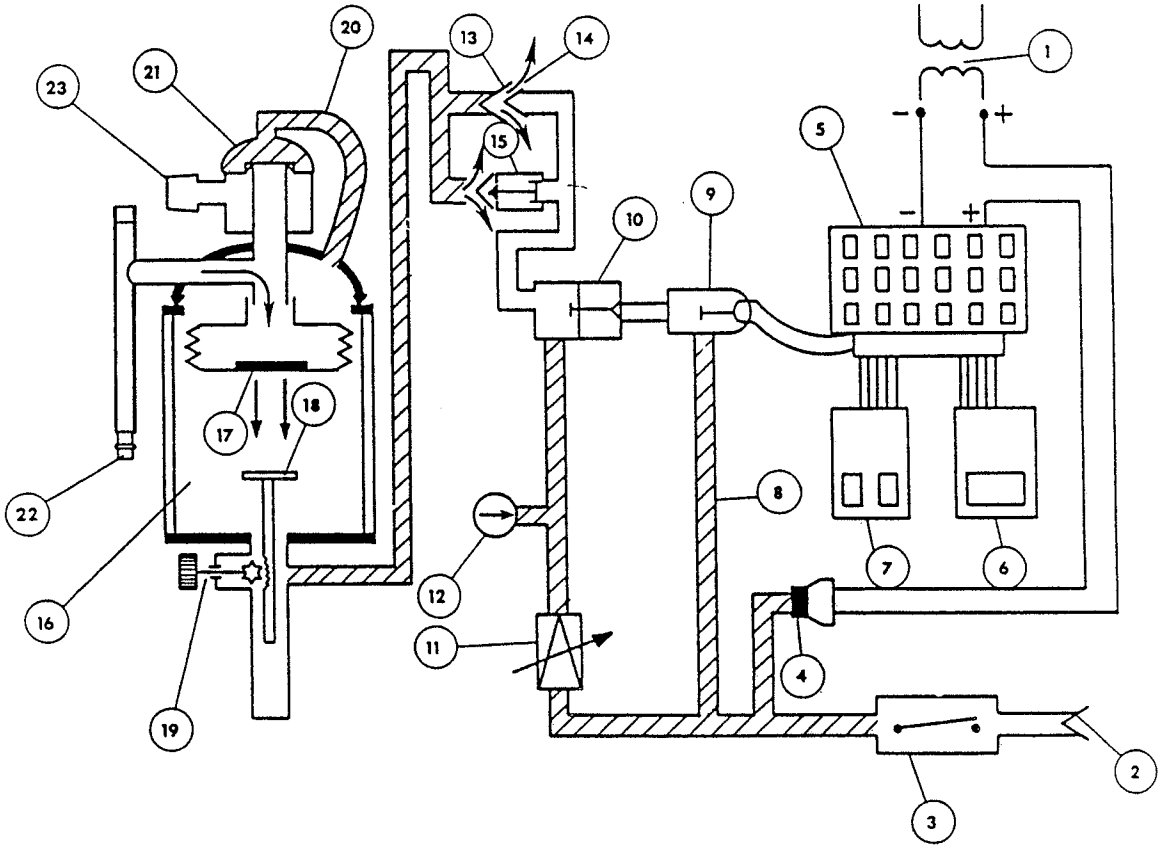


INSPIRATORY PAUSE TIME

The inspiratory pause time (inspiratory pause) starts at the time when the bellows stop the upward movement and lasts until the downward movement of the bellows begins.

All pneumatic and electronic functions remain the same as during the inspiratory flow time. The pressure in the bellows chamber (16), as preset with the flow regulator (11) cannot increase further. Therefore, all excess pressure is released through the entrainment port (14). Venturi (13) does not entrain air into the system at this point.

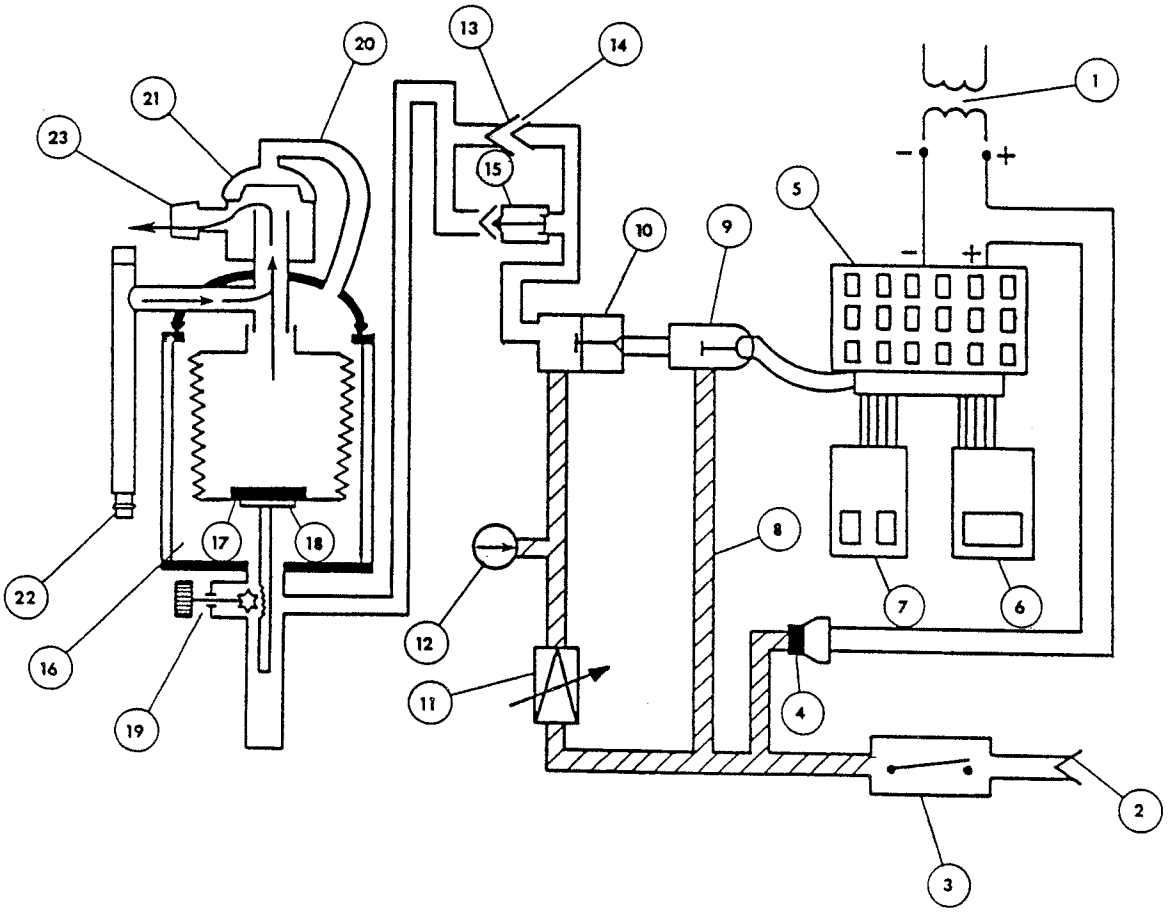
EXPIRATORY FLOW TIME



EXPIRATORY FLOW TIME

Based on frequency and I:E ratio setting on frequency control (7) and I:E ratio control (6), the expiratory flow time begins when the electric signal from the AV-E P.C. Board (5) is no longer supplied to solenoid valve (9). As soon as the electric signal stops, solenoid valve (9) is deactivated and closes. This stops the gas supply of 50 psi pressure to control valve (10), which becomes also deactivated and closes. The preset gas flow from flow regulator (11) is interrupted by control valve (10). This causes an immediate pressure drop at venturi (13) and no back pressure is supplied to pilot actuator (15). This valve opens and allows gas from bellows chamber (16) to discharge through pilot actuator (15), but also through the entrainment port (14) of venturi (13). As the pressure drops in bellows chamber (16), the bellows (17) begin to move downward. As long as any pressure still remains in bellows chamber (16), ventilator relief valve (21) is also pressurized and remains closed.

EXPIRATORY PAUSE TIME

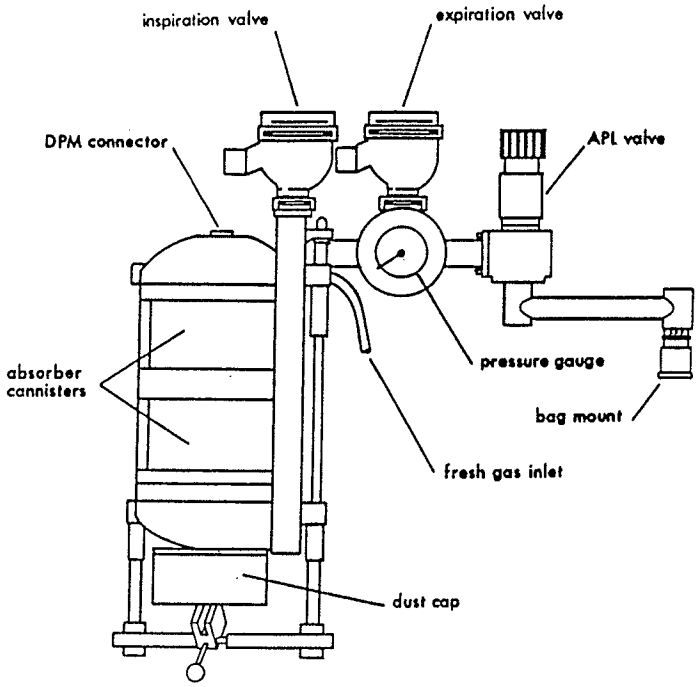


EXPIRATORY PAUSE TIME

The expiratory pause time (expiratory pause or resting period) starts at the time when the bellows stop the downward movement (bellows resting on tidal volume adjustment plate 18) and lasts until the upward movement of the bellows begins.

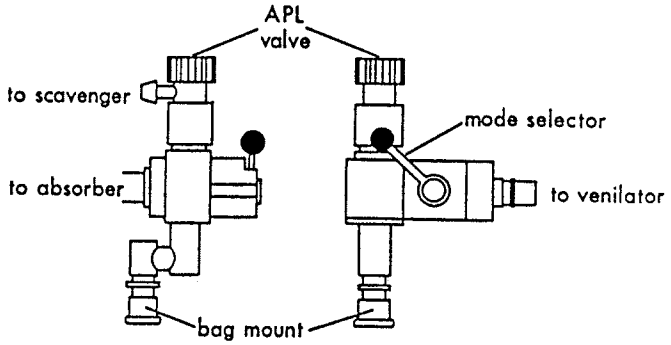
All pneumatic and electronic functions remain the same as during the expiratory flow time with the exception of ventilator relief valve (21). Since no pressure remains in the bellows chamber (16), no pressure is transmitted via pilot line (20) to ventilator relief valve (21). Therefore, this valve is open and residual exhaled gases as well as excess fresh gas flow are discharged through the waste gas scavenging system connector (23) into the scavenger interface.

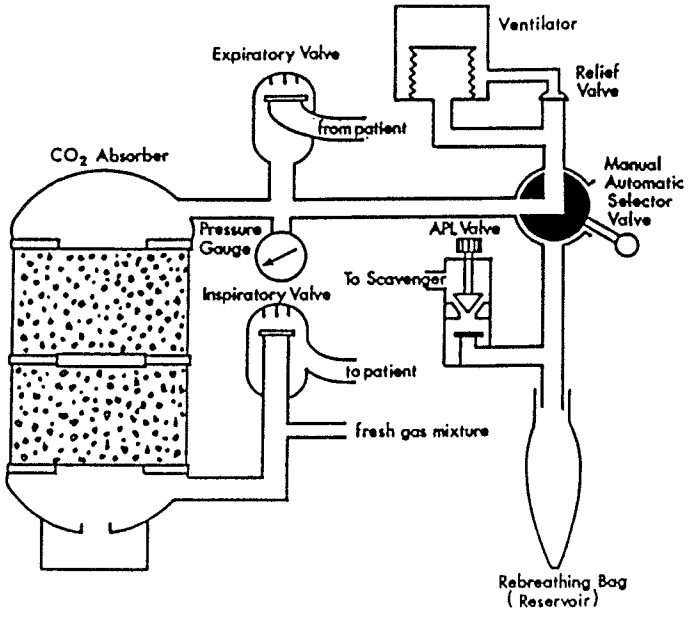
NAD CO_2 ABSORBER SYSTEM



CO_2 ABSORBER SYSTEM

MANUAL/AUTOMATIC SELECTOR VALVE





PATIENT BREATHING SYSTEM

CO_2 ABSORBER SYSTEM

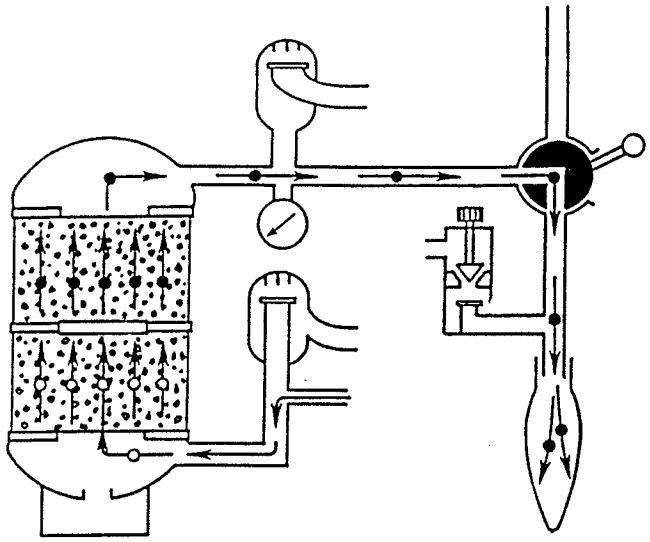
The purpose of the absorber system is to direct inspired and expired gases to and from the patient through unidirectional valves without allowing the patient to rebreathe his own exhaled carbon dioxide (CO_2). A breathing (reservoir) bag allows for accumulation of gases during expiration but also compensates for pressure changes in the breathing circuit. The inspiratory pressure is controlled by the adjustable pressure limiter (APL) valve and can be observed on the absorber pressure gauge.

MANUAL/AUTOMATIC SELECTOR VALVE

This valve is only required when a ventilator is being used instead of a breathing bag. When switched to ventilator mode the function of the breathing bag and the APL valve are eliminated while the ventilator with the automatically controlled relief valve become part of the patient breathing system.

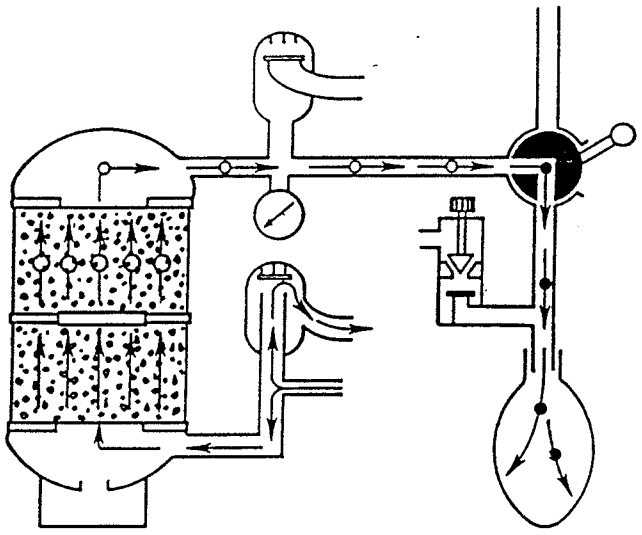
PATIENT BREATHING SYSTEM

The patient breathing system shows the CO_2 absorber with inspiratory and expiratory valves as well as fresh gas inlet and pressure gauge. The manual/automatic selector valve is shown in the ventilator mode, by-passing the breathing bag and the APL valve.



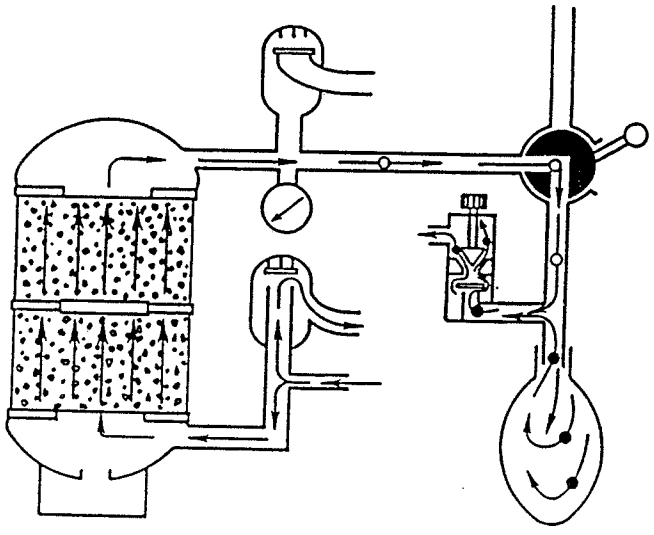
fresh gas mixture (100% oxygen)
exhaled gas with CO_2
exhaled gas without CO_2

OXYGEN FLUSH
Step 1



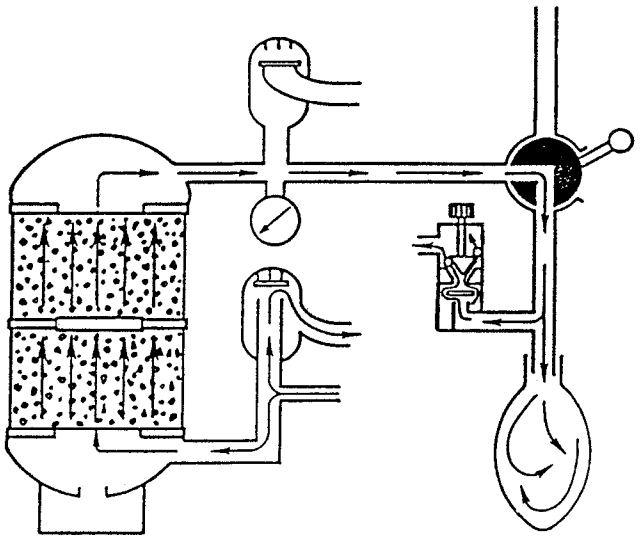
fresh gas mixture (100% oxygen)
exhaled gas with CO_2
exhaled gas without CO_2

OXYGEN FLUSH
Step 2



fresh gas mixture (100% oxygen)
exhaled gas with CO_2
exhaled gas without CO_2

OXYGEN FLUSH
Step 3



fresh gas mixture (100% oxygen)
exhaled gas without CO_2

OXYGEN FLUSH
Step 4

OXYGEN FLUSH (STEP 1)

Activation of the flush valve charges the patient breathing system with 100% oxygen. Exhaled gases from the previous exhalation, which are still in the absorber system, are forced towards the breathing bag. Some of the exhaled gas still contains CO_2 while gas which had already entered the CO_2 absorber does not.

OXYGEN FLUSH (STEP 2)

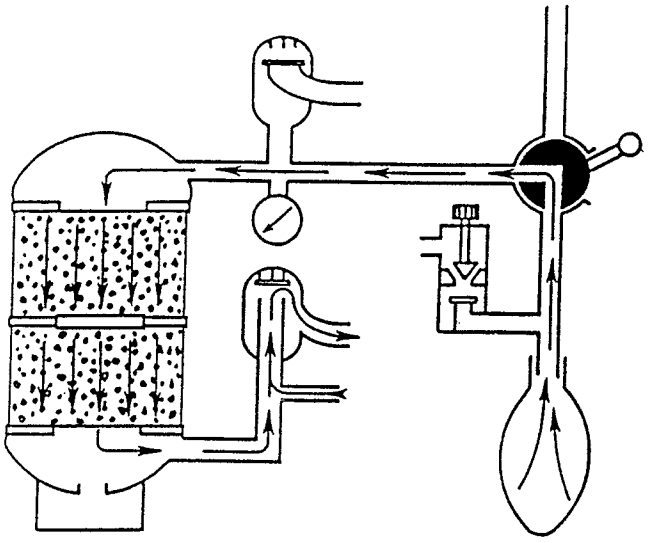
As the oxygen flush continues a minimal pressure opens the inspiratory valve while at the same time more gas is forced into the breathing bag.

OXYGEN FLUSH (STEP 3)

As the breathing bag expands, a pressure build-up in the breathing system will open the APL valve for some of the gas to escape. The opening pressure of the APL valve depends on the manual adjustment of this valve.

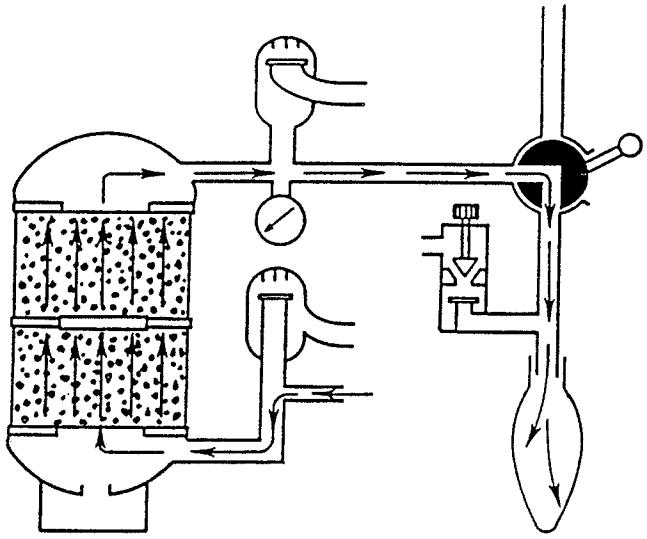
OXYGEN FLUSH (STEP 4)

Eventually all exhaled gases will be purged from the patient breathing system and be replaced with 100% oxygen. The APL valve will remain open (depending on manual adjustment) and all excess gas (100% oxygen) will be directed into the scavenger system.



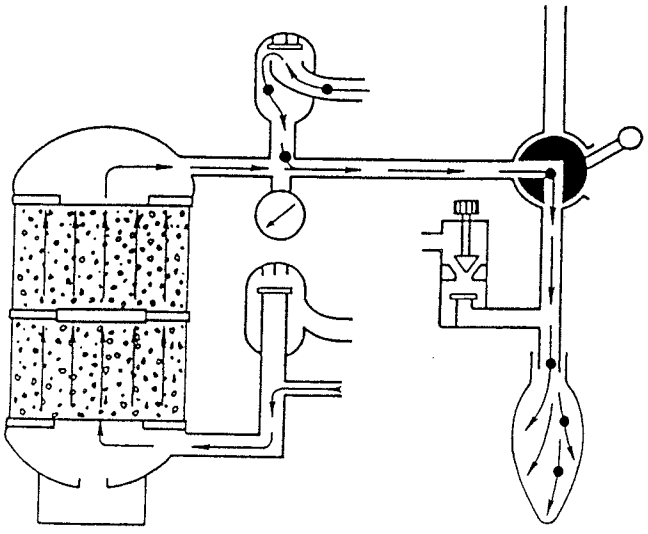
fresh gas mixture

SPONTANEOUS INSPIRATION
Step 5



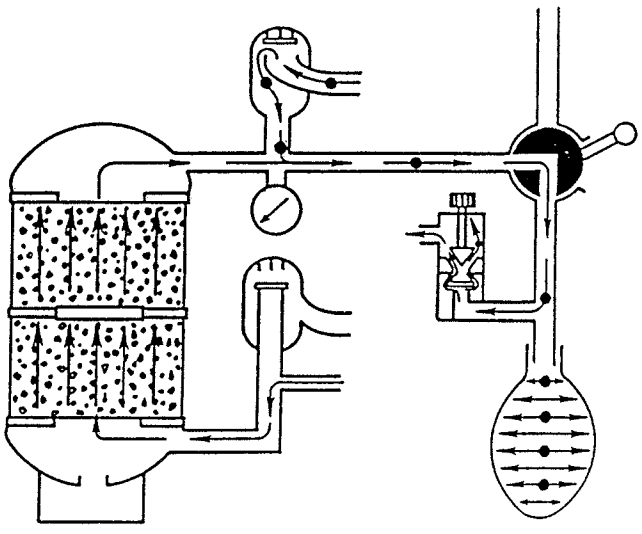
fresh gas mixture

INSPIRATORY PAUSE
Step 6



fresh gas mixture
exhaled gas with CO_2

EXPIRATION
Step 7



fresh gas mixture
exhaled gas with CO_2

EXPIRATION
Step 8

SPONTANEOUS INSPIRATION (STEP 5)

The patient is inhaling by drawing gas from the breathing bag (100% oxygen). The inspiratory valve opens, but no positive pressure develops. Since the flush valve is no longer activated, the fresh gas mixture contains oxygen, nitrous oxide and anesthetic vapor.

INSPIRATORY PAUSE (STEP 6)

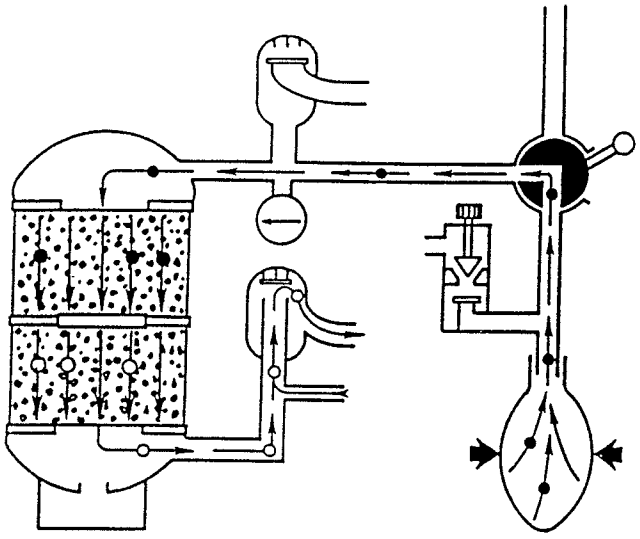
Gas flow to the patient stops just prior to exhalation. All of the fresh gas mixture is now directed towards the breathing bag. Inspiratory and expiratory valves are closed.

EXPIRATION (STEP 7)

The expiratory valve opens as the patient exhales. The exhaled gas is directed to the breathing bag which begins to fill with exhaled gas containing CO_2 and fresh gas mixture.

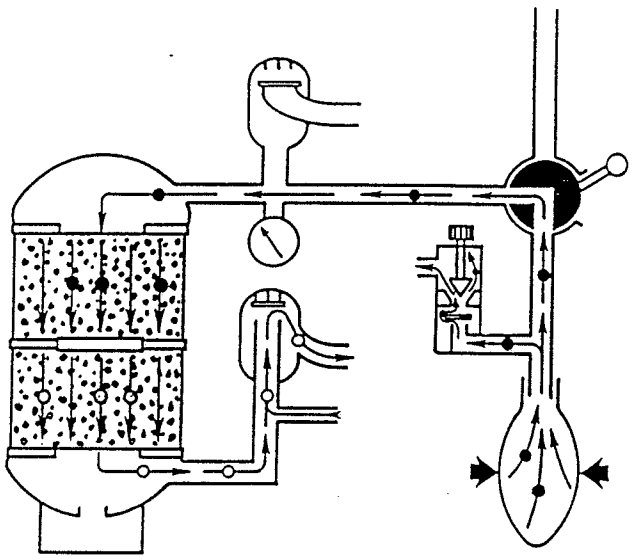
EXPIRATION (STEP 8)

As the breathing bag fills with exhaled gas and fresh gas mixture, the pressure in the patient breathing system rises slightly and the APL valve (depending on manual adjustment) opens to allow for all excess gases (exhaled and fresh) to be directed into the scavenger system.



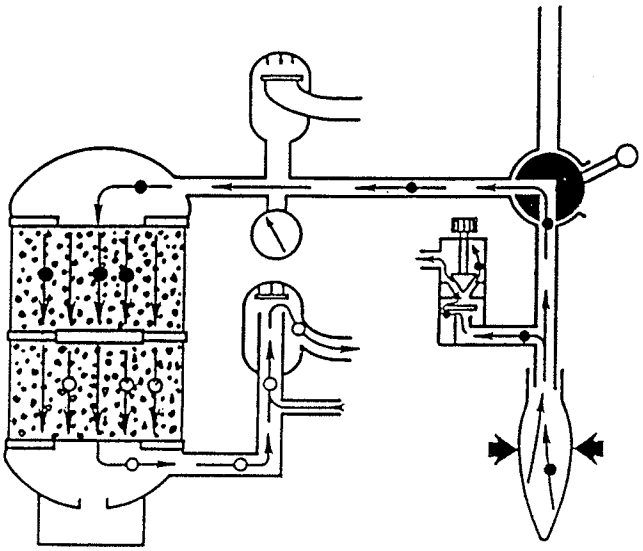
fresh gas mixture
exhaled gas with CO_2
exhaled gas without CO_2

ASSISTED MANUAL VENTILATION
Step 9



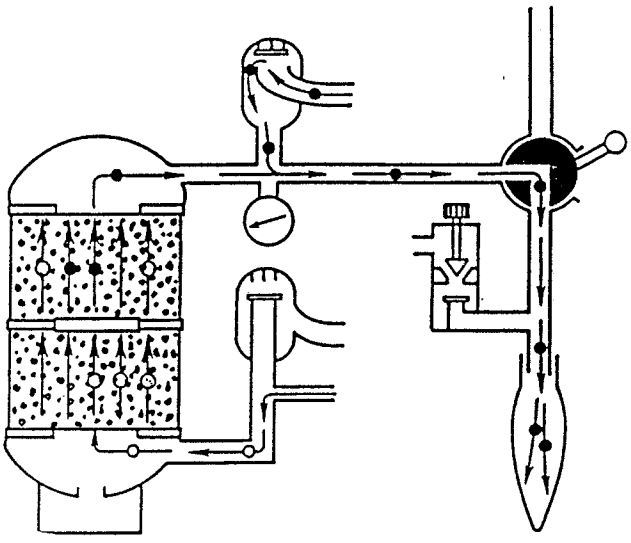
fresh gas mixture
exhaled gas with CO_2
exhaled gas without CO_2

ASSISTED MANUAL VENTILATION
Step 10



fresh gas mixture
exhaled gas with CO_2
exhaled gas without CO_2

ASSISTED MANUAL VENTILATION
Step 11



fresh gas mixture
exhaled gas with CO_2
exhaled gas without CO_2

EXHALATION
Step 12

ASSISTED MANUAL VENTILATION (STEP 9)

When the breathing bag is compressed manually fresh gas mixture and exhaled gas is forced through the absorber towards the patient. In the absorber all exhaled CO_2 is removed. As indicated on the pressure gauge, the system pressure begins to rise and the inspiratory valve opens.

ASSISTED MANUAL VENTILATION (STEP 10)

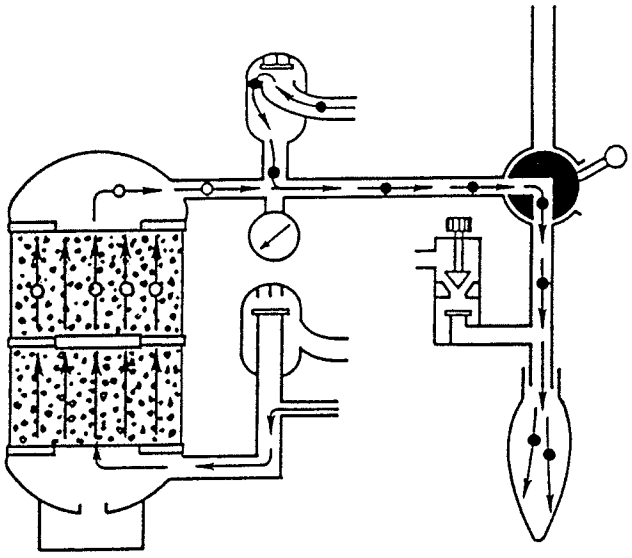
Depending on the adjustment of the APL valve, the valve will open when a certain pressure is reached by compressing the bag. Excess gases (fresh and exhaled) are directed into the scavenger system.

ASSISTED MANUAL VENTILATION (STEP 11)

Most of the gas from the breathing bag is used to assist the patient during inspiration.

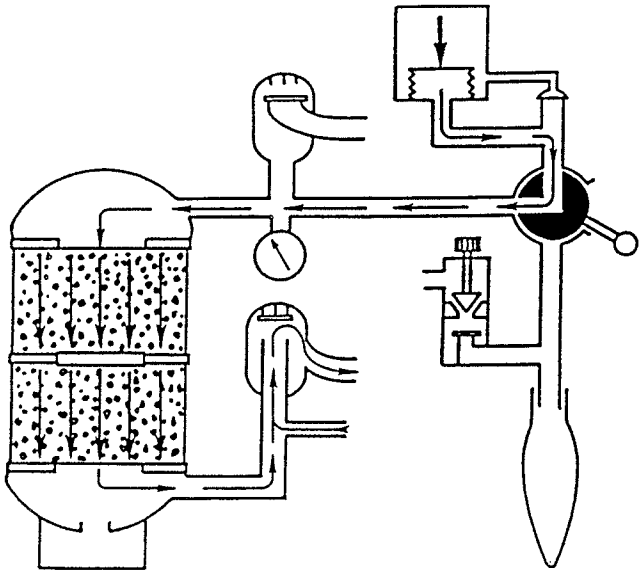
EXHALATION (STEP 12)

As expiration begins the expiratory valve opens and allows the patient to exhale. The inspiratory valve is closed and the fresh gas mixture forces the remaining exhaled gases in the absorber system towards the breathing bag. The system pressure has almost dropped to 0 (zero).



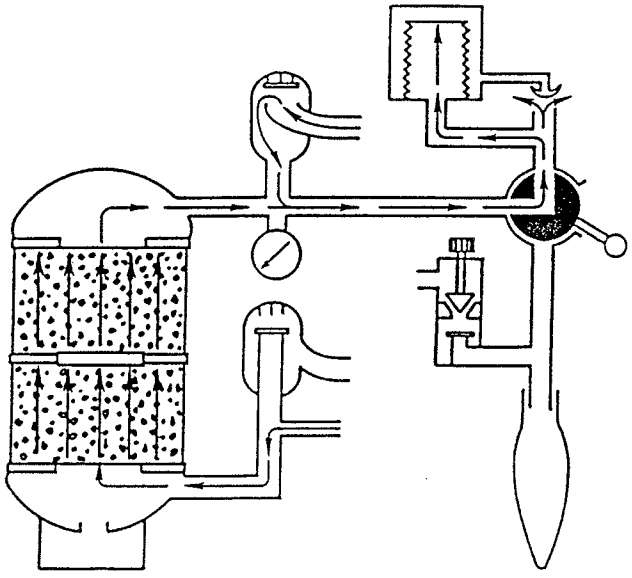
fresh gas mixture
exhaled gas with CO_2
exhaled gas without CO_2

EXHALATION
Step 13



mixed gases

VENTILATOR MODE
(Inspiration)



mixed gases

VENTILATOR MODE
(Expiration)

EXHALATION (STEP 13)

Pressure has dropped to 0 (zero) and exhaled gases as well as fresh gas mixture are filling the breathing bag. The cycle continues with step 8.

VENTILATOR MODE (INSPIRATION)

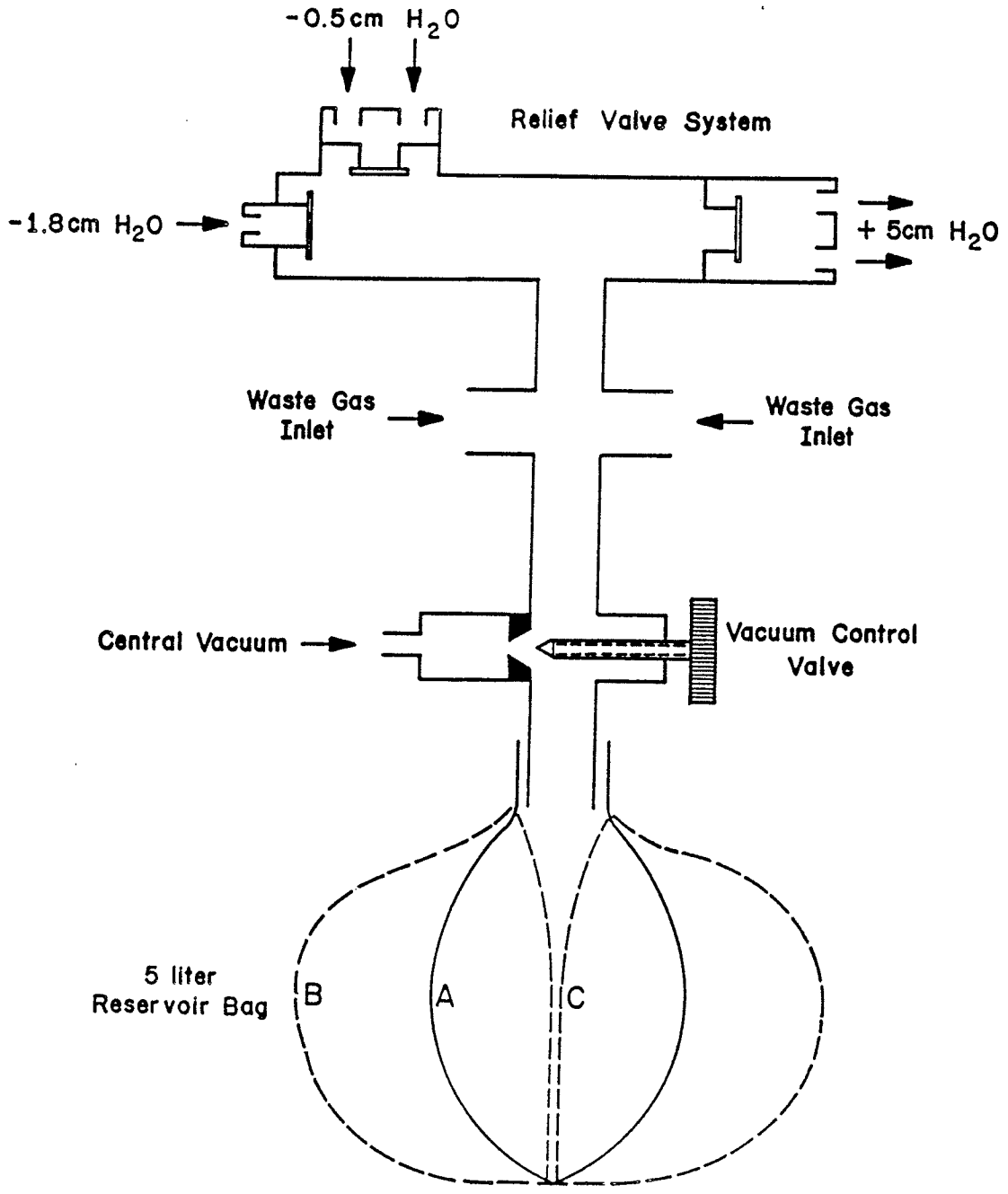
An automatic ventilator is being used instead of manual operation. The manual/automatic selector valve is switched to ventilator mode. The breathing bag is replaced with the bellows of the ventilator. A ventilator relief valve, which automatically closes during inspiration, replaces the APL valve. Exhaled gases and fresh gas mixture air forced from the ventilator bellows to the patients. The system pressure is rising.

VENTILATOR MODE (EXPIRATION)

The exhaled gases and fresh gas mixture are directed towards the ventilator bellows. The ventilator relief valve opens automatically and excess gases are directed into the scavenger system. The system pressure has dropped to 0 (zero).

SCAVENGER INTERFACE
FOR
CENTRAL VACUUM SYSTEM

SCAVENGER INTERFACE



SCAVENGER INTERFACE

The Scavenger Interface for vacuum can be used in conjunction with the central hospital vacuum system (patient suction system) or with seperate vacuum system especially dedicated for the removal of waste gases.

All waste gases produced during general anesthesia are channeled via the APL valve or ventilator relief valve to the scavenger interface.

The hospital vacuum system is connected to the vacuum DISS male connector and a 5 (five) liter reservoir bag is attached to the bag mount of the scavenger interface. A control valve allows for the correct adjustment of the vacuum. The reservoir bag serves as a pressure compensator. It is important to adjust the vacuum control valve in such a manner that the reservoir bag is never overextended (B) or completely deflated (C).

Since a variable volume of waste gas is dumped into the scavenger system intermittently, while the vacuum remains relatively constant, it may be necessary to adjust the vacuum control valve during anesthesia. The reservoir bag will serve as the indicator for the correct setting, (condition A).

Exhaled humidity must not be allowed to accumulate in scavenger hoses or other parts of the scavenger system, as it may cause PEEP.

A positive pressure relief valve, which is preset at 5cm H_2O, will prevent a positive pressure build-up above this level in case the central vacuum system should fail. Waste gas will be expelled into the atmosphere if this condition occurs.

If the vacuum is set higher than necessary to evacuate the waste gas, a relief valve will allow ambient gas (air) to enter the scavenger system, when a sub-atmospheric pressure of -0.5cm H_2O is created. A back-up valve will be activated at -1.8cm H_2O, if the primary relief valve should fail.

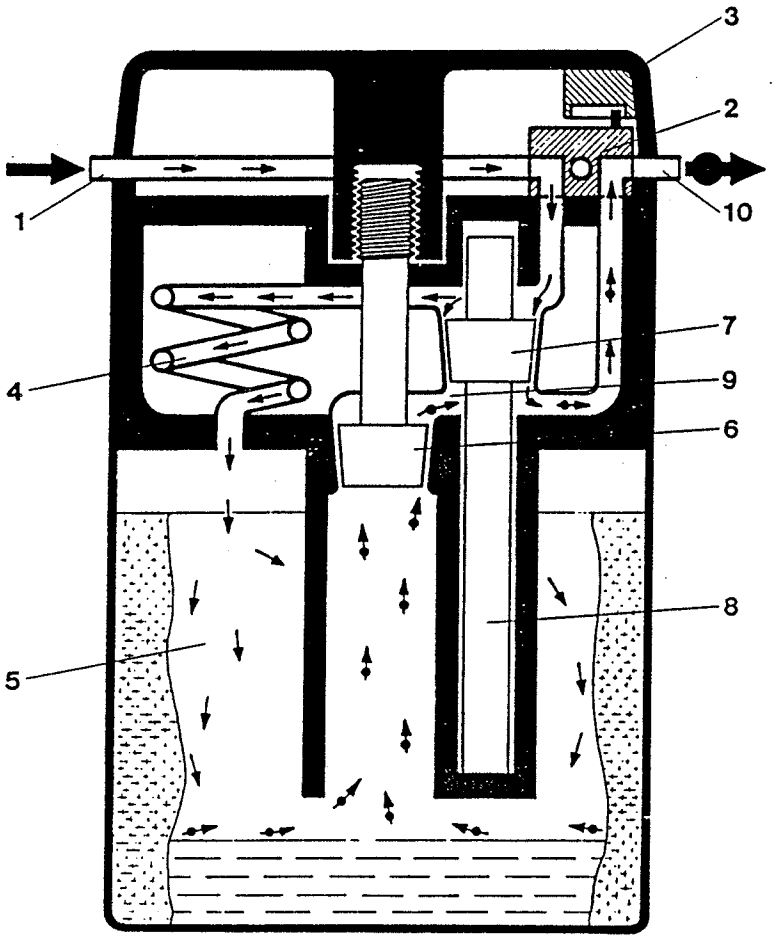
VAPOR VAPORIZER 19.1

WARNING

THE ENCLOSED MATERIAL IS FOR INFORMATION ONLY!

NEVER ATTEMPT TO OPEN A VAPOR VAPORIZER
NEVER ATTEMPT TO CALIBRATE A VAPOR VAPORIZER
NEVER ATTEMPT TO REPAIR A VAPOR VAPORIZER
ALWAYS SEND VAPOR VAPORIZERS WHICH REQUIRE SERVICE TO NORTH AMERICAN DRAGER TECHNICAL SERVICE DEPARTMENT

VAPOR 19.1



1. fresh gas inlet
2. turn on and turn off control (actuated by concentration knob)
3. concentration knob
4. pressure compensation (patented)
5. vaporizing chamber
6. control cone
7. vaporizing chamber, by-pass cone
8. expansion member for temperature compensation
9. mixing chamber
10. fresh gas outlet

FRESH GAS

FRESH GAS WITH ANESTHETIC VAPOR

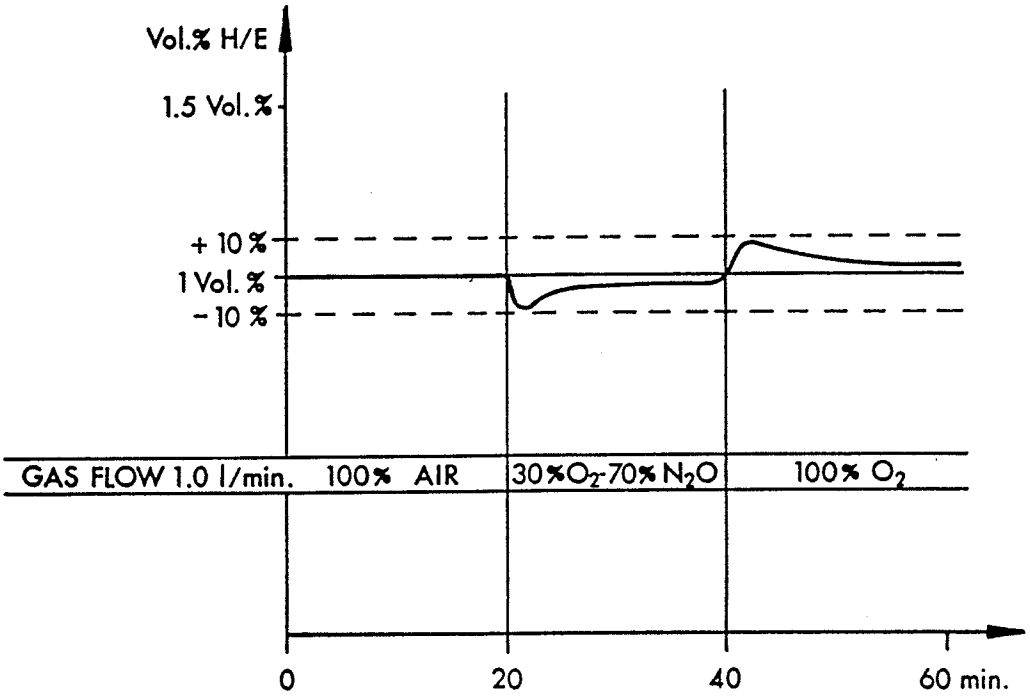
VAPORIZER GAS FLOW

When the concentration knob (3) is in the 0 (zero) position, the ON/OFF switch (2) is closed. The gas mixture enters the vaporizer at fresh gas inlet (1) and leaves through the fresh gas outlet (10) without entering the interior of the vaporizer.

When concentration knob (3) is turned to any volume% concentration above 0.2 volume%, the ON/OFF switch (2) automatically opens and allows the fresh gas to enter the interior of the vaporizer.

The gas is immediately divided and follows 2 (two) different routes. One part of the fresh gas moves through a thermostatically controlled by-pass (7), which compensates for temperature changes and maintains the correct volume% concentration vapor output as selected with concentration knob (3). The other part of the fresh gas moves through a pressure compensator (4), which prevents pressure changes that occur upstream or downstream of the vaporizer to be transmitted into the vaporizer and thus effect the volume% vapor output. From the pressure compensator the gas continues into the vaporizer chamber (5). This chamber contains the liquid anesthetic agent which is absorbed and evaporated by a special wick assembly. As the fresh gas moves through the vaporizing chamber, it is fully saturated with anesthetic vapor. The staurated gas leaves the chamber through control cone (6). The cone is adjustable with concentration knob (3). The saturated gas and the fresh gas which did not move through the vaporizing chamber are combined and leave through fresh gas outlet (10).

The combination of the by-pass opening (7) and the control cone opening (6) determines the volume% vapor output. Other factors as discussed in the following paragraphs have also an effect on the correct vapor concentration.


Vol.% H/E
1.5 Vol.%
+ 10 %
1 Vol. %
- 10 %
GAS FLOW 1.0 l/min.
100% AIR
30%O2-70% N2O
100% O2
0
20
40
60 min.

EFFECTS OF DIFFERENT GAS MIXTURES ON VOLUME% CONCENTRATION

All Vapor vaporizers 19.1 are calibrated with air by the manufacturer. Since most vaporizers are operated with pure oxygen or oxygen/nitrous oxide mixtures, the volume% vapor output is effected.

A Vapor vaporizer which is set to 1.0 volume% concentration at a gas flow of 1 l/min, will show the following characteristics:

GAS FLOW - AIR

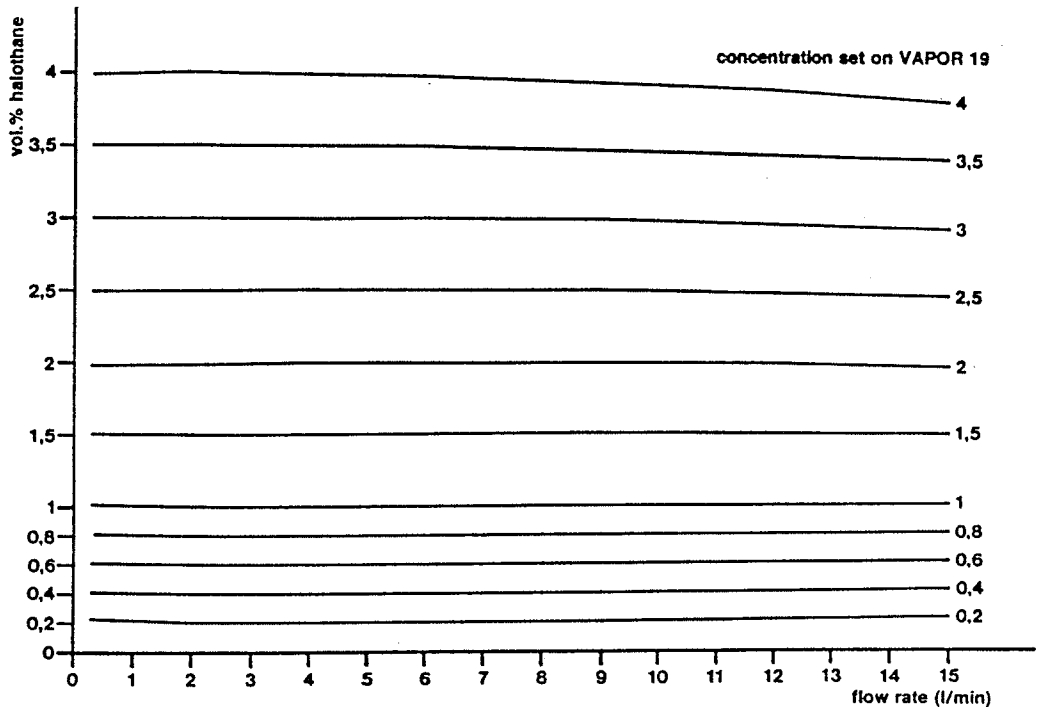
Concentration constant at 1.0 volume% output

GAS FLOW - 30% O_2 & 70% N_2O

Concentration will sharply drop and then remain slightly below 1.0 volume% output

GAS FLOW - 100% O_2

Concentration will sharply rise and remain slightly above 1.0 volume% output


vol.% halothane
concentration set on VAPOR 19
4
3,5
3
2,5
2
1,5
1
0,8
0,6
0,4
0,2
0
0 1 2 3 4 5 6 7 8 9 10 11 12 13 14 15
flow rate (l/min)

EFFECTS OF FRESH GAS FLOWRATE ON VOLUME% CONCENTRATION

While Vapor 19.1 vaporizers produce a relative constant volume% concentration at fresh gas flowrates between 2 and 10 l/min, the following observation can be made at gas flows below 2 l/min or above 10 l/min:

GAS FLOW LESS THAN 2 L/MIN

Slight increase of volume% concentration up to 1.0 volume%. Constant concentration from 1.0 to 4.0 volume% concentration

GAS FLOW HIGHER THAN 10 L/MIN

Basically constant volume% concentration up to 1.5 volume%. Gradual decrease of vapor output as volume% concentration setting is increased.

A decrease of volume% concentration between 3.0 and 4 volume% may already be noticable at flowrates of less than 10 l/min.

TEST INSTRUMENTS

REQUIRED MATERIAL

1.0. Literature

2.0. Test Instruments

3.0. Tools

4.0. Supplies

Required Material

The following literature, test instruments, tools and supplies are required for the entire anesthesia equipment training program:

1.0. **Literature**

1.1. NAD Service Manual
1.2. Operator's Manual

2.0. **Test Instruments**

2.1. NAD Flowmeter Test Stand - S000058 A
2.2. Drager Minute Volumeter 3000 - 2212300 A
2.3. Pressure Switch Tester - 4105465 A
2.4. Oxygen Monitor - 4106158 A
2.5. Multimeter Model 22-191 (Radio Shack)
2.6. Riken Gas Analyzer Model 18
2.7. Drager Training Thorax - 2113333 A
2.8. Regulator Test Gauges:
    Oxygen - S000063 A
    Nitrous Oxide - S000064 A
2.9. Pipeline Pressure Gauges
    Oxygen - S000083 A
    Nitrous Oxide - S000084 A
2.10. Micro Pump Automatic Halogen Leak Detector TIF 5500 (TIF Instruments INC.)
2.11. Test Terminal With BP Bulb

3.0. **Tools**

3.1. Standard Type
    Allen wrenches (smallest .50)
    Open end wrenches
    Flat screw drivers
    Combination pliers
    Regular pliers
    Vise grip
    Wire cutters
    Knife
    Small hammer
    Adjustable wrenches
    Needle nose pliers

3.2. Special Type
    Allen wrenches (10" - 12" long)
    Metric allen wrench 3mm

4.0. **Supplies**

4.1. Leak Detector
4.2. Unbrako Loctite
4.3. Stop Cock Grease - 4105908 A
4.4. Teflon Tape
4.5. Various sizes cable ties

2.1. Flowmeter Test Stand
S000058 A

1.0. The calibrated test flowmeter is used to check anesthesia flowmeters for correct readings

2.0. Testing the Anesthesia Oxygen Flowmeters:

2.1. Turn all flowmeters and vaporizers on anesthesia machine OFF
2.2. Connect test flowmeter to common outlet
2.3. Set oxygen flow on anesthesia machine to a given flow rate. The test flowmeter should indicate the same flow rate

3.0. Follow above procedure when testing other gases

3.1. NOTE:
Always consult calibration table for the test flowmeter to determine the exact conversion factor

4.0. -If test flowmeter shows higher flow than anesthesia flowmeter:
flowtube may be dirty
-If test flowmeter shows lower flow than anesthesia flowmeter:
check system for leaks

2.2. Volumeter 3000
2212300 A

1.0. The volumeter can be used to determine the flow of the oxygen flush system and tidal volumes as delivered by the ventilator

2.0. Testing the Oxygen Flush System:

2.1. Turn all flowmeters OFF (on NM2, turn main switch to OFF position)
2.2. Disconnect fresh gas hose from common outlet
2.3. Connect metal elbow to volumeter
2.4. Connect hose with 15mm and 22mm connectors to metal elbow and fresh gas outlet
2.5. Depress left button on volumeter (see Fig. 3 of Volumeter Instructions)
2.6. Depress oxygen flush button until volumeter timer stops. Minute ventilation of oxygen flush should be approximately 50 l/min (at least 3 full revolutions of small hand on volumeter)

3.0. Testing of Tidal Volumes:

3.1. Attach volumeter below the expiratory valve on the anesthesia machine (see Fig. 2 of Volumeter Instruction)
3.2. Set manual/automatic selector switch to AUTOMATIC
3.3. Select tidal volume and turn ventilator ON
3.4. Depress right button of volumeter (see Fig.4 of Volumeter Instruction) while bellows is resting in the DOWN position
3.5. Depress right button **half way** as soon as bellows comes to rest in the UP position
3.6. NOTE:
The tidal volume reading on the volumeter may vary from the preset tidal volume depending on circuit compliance

A considerably lower registered tidal volume compared to the preset tidal volume may be caused by a leak in the system

2.3. Pressure Switch Tester
S4105465 A

1.0. Product Description

The pressure switch tester is a device to test the performance of pressure sensitive switches as used in North American Drager pressure monitors. It allows to simulate pressure related clinical conditions to determine the proper function of pressure monitor alarms. The pressure switch tester can also be used to test Dehart and MPL switches individually.

2.0. Specifications

Power Source: Four 1.5 volt alkaline batteries, Size C

Pressure Indicator: NAD pressure gauge - minus 20cm H_2O to plus 80cm H_2O

Pressure Release: MJV clippard valve

Pneumatic Input and Output: Female luer connectors

Audible Alarm: Sonalert® 4-28 volts DC

Electrical Connectors: Banana jack positive (+ red), Banana jack negative (– black)

3.0. Accessories

1 ea. S4105437 - red test connector
1 ea. S4105438 - black test connector
1 ea. S4105436 - disposable syringe
1 ea. pneumatic input PVC tubing S8808002, with hose barb S4105443 (syringe) and male luer connector S1101395 (input)
1 ea. pneumatic test PVC tubing S8808002 for MPL switch with male luer connector S1101395 (output)
1 ea. small diameter PVC tubing S8808003 and reducer S4102164 to convert pneumatic test tubing to dehart switch
1 ea. test PVC tubing S8808002 with male luer connector (output) and quick disconnect S4103449 for connection to Narkomed 2 alarm channel

4.0. Calibration

The cm H_2O pressure gauge should be calibrated against a cm H_2O water column

4.1. Remove the gauge glass from the pressure gauge by carefully inserting a small screwdriver into the slot under the gauge glass rim on the bottom of the pressure gauge
4.2. Attach the pneumatic input tubing to the syringe and the input luer connector of the tester
4.3. Connect the pneumatic test tubing to the water column gauge and the output luer connector
4.4. Push syringe plunger until 10cm H_2O positive pressure is indicated on the water column gauge. The pressure gauge on the pressure switch tester should also indicate plus 10cm H_2O
4.5. Continue above procedure at 20, 30, 40, 50, 60, 70, and 80cm H_2O
4.6. The cm H_2O pressure gauge can be adjusted to the proper setting by turning the set screw on the bottom of the dial face (clockwise - positive; counterclockwise - negative)
4.7. It may be necessary to develope a conversion table for different pressures, if adjustment of set screw does not produce satisfactory results
4.8. Negative pressure can be created by drawing the syringe plunger

5.0. Operation of Pressure Switch Tester

NOTE:
The pressure switch tester (Fig.1) must be operated in conjunction with PMS procedures 14.0 to 17.0 and service procedure 5.6.0.0.

Operation of Pressure Switch Tester

5.1. To use tester for checking alarm channel of NM2, NM2A or AM III

Attach test tubing with quick disconnect to female quick disconnect on NM2, NM2A or AM III alarm channel and to pneumatic output of tester. Connect syringe with input tubing to pneumatic input. Follow procedure 14.6 to 17.2 of the Preventive Maintenance Manual to test pressure functions of the alarm channel.

5.2. To use tester for checking individual MPL or dehart pressure switches

Attach test tubing with male luer connector to pneumatic output and MPL switch. Insert reducer with small diameter plastic tubing between test tubing and dehart pressure switch when testing dehart switches. Follow procedure 5.6.0.0. to determine proper function of pressure switch.

5.3. NOTE:
A multimeter, as described in procedure 5.6.1.8. and 5.6.4.6., is not required. Instead, test leads should be connected to pressure switch tester (Fig. 2). The Sonalert will be activated when electrical contacts of the pressure switch are closed.

5.4. The pressure in the system (positive or negative) can be eliminated by pressing the pressure release button (Fig. 1)

PRESSURE SWITCH TESTER

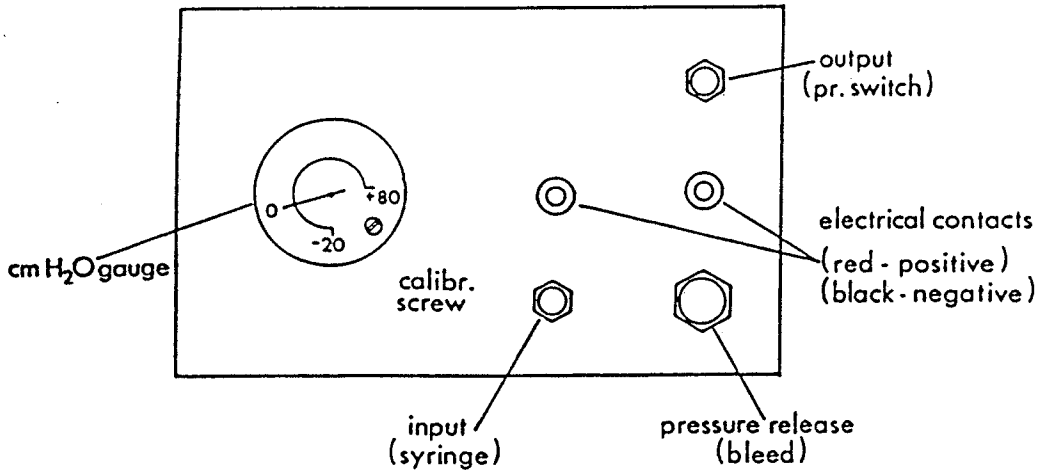


Figure 1

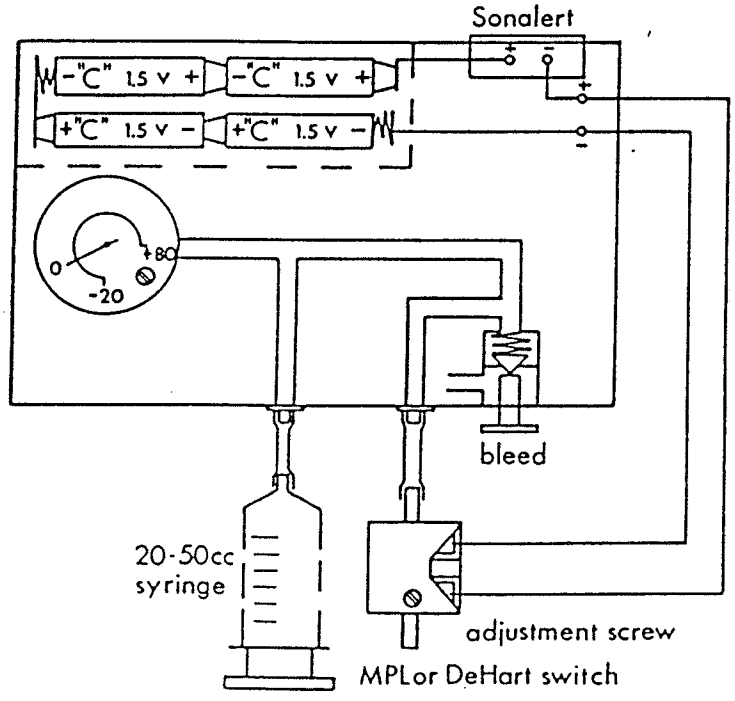


Figure 2

2.4. Oxygen Monitor

For Test Purposes, use a NAD/IL Monitor 4106158 A

2.5. Multimeter

North American Drager recommends the use of a Multimeter such as Radio Shack Model 22-191 for all electrical tests

2.6. Gas Analyzer

1.0. The gas analyzer is used to test vaporizer volume% concentration of anesthetic agents in 100% O_2

2.0. **Testing Vapor Concentrations**
See Vapor Vaporizer Test Procedure in Preventive Maintenance Section

2.7. Training Thorax

One or two Drager Training Thorax must be used to properly evaluate the anesthesia machine, anesthesia ventilator and patient breathing system.

2.8. Regulator Test Gauges
Oxygen Regulator Test Gauge S000063 A
Nitrous Oxide Regulator Test Gauge S000064 A

1.0. Regulator test gauges are used to determine the correct output pressure of the regulator. This is of particular importance when O.R.M. or O.R.M.c. devices are employed in the gas circuit

2.0. Following are the output pressures for oxygen and nitrous oxide regulators

At gas flow of 4 l/min:	O_2	N_2O
No O.R.M. or O.R.M.c.	40psi	40psi
O.R.M.	45psi	45psi
O.R.M.c.	48psi	45psi

3.0. All other regulators are set at 40psi

4.0. To determine the correct regulator output pressure (e.g. after the regulator was replaced) the following steps must be taken

5.0. Remove the table top

6.0. Locate the regulator to be tested by tracing the copper pipe from the yoke (oxygen or nitrous oxide) to the regulator

7.0. Downstream of the regulator low pressure side is a T-piece which contains a blind plug (Fig.1)

8.0. Before removing this blind plug make sure that all gas sources are turned OFF

9.0. Connect the correct test gauge to the T-piece

10.0. Remove the acorn nut of the regulator (Fig. 2)

11.0. Turn the appropriate cylinder ON. (If nitrous oxide regulator is tested the oxygen must also be ON)

12.0. Turn gas flow (oxygen or nitrous oxide) to 4 l/min on the flowmeter

13.0. By turning the set screw on the regulator clockwise or counterclockwise, the output pressure will decrease or increase (Fig. 2)

14.0. Set pressure to correct value as shown in point 2

15.0. Replace acorn nut and check that pressure does not vary

16.0. Turn cylinder OFF and drain system of residual gas

17.0. Turn flowmeter OFF and remove test gauge

18.0. Apply teflon tape to blind plug and replace

PRESSURE REDUCING REGULATOR

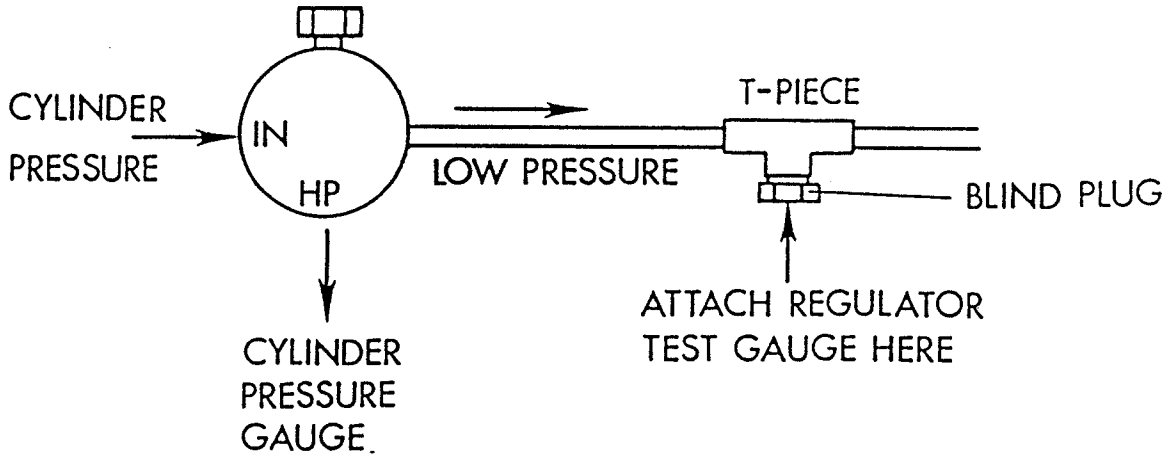


Figure 1

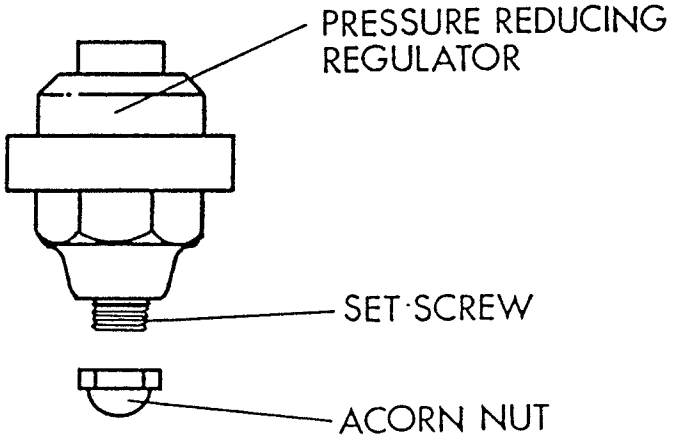


Figure 2

2.9. Pipeline Pressure Test Gauges
Oxygen Pipeline Pressure Test Gauge S000083 A
Nitrous Oxide Pipeline Pressure Test Gauge S000084 A

1.0. Pipeline pressure gauges are used to determine malfunctions in the hospital medical gas supply system

2.0. The pipeline pressure test gauge is connected between the medical gas supply hose (oxygen or nitrous oxide) and the DISS Inlet of the anesthesia machine

3.0. If, for example, pressure variations are detected in the oxygen supply system, the following procedure should be applied:

3.1. Connect the oxygen pipeline pressure test gauge as described in point 2
3.2. Turn all flowmeters and ventilators which are incorporated into the anesthesia machine OFF
3.3. Check and mark pipeline pressure as noted on test gauge
3.4. Activate oxygen flush button. See if and how much pressure drops
3.5. Turn ventilator on and see if and how much pressure drops during the inspiratory cycle
3.6. Turn oxygen flowmeter to 10 l/min and check for pressure drop

4.0. If the pressure drops more than 2psi when one or all of the above functions are activated the oxygen piping system is probably underated for normal consumption

2.10. Leak Detector

The TIF Leak Detector Model 5500 allows for convenient and fast determination of leaks in the anesthesia system

2.11. Test Terminal

A test terminal 4104389 A, coiled sphygmomanometer tubing 4103084 P and a sphygmomanometer bulb with a valve 5088010 A is needed to pressure test the absorber. Follow procedure 8.0. of the Preventive Maintenance section of this manual.

3.0. Tools

1.0. Regular Tools

- Box wrenches
- Allen wrenches
- Adjustable wrenches
- Combination pliers
- Needle nose pliers
- Wire cutters
- Screw drivers (flat)
- Small hammer

2.0. Special Tools

- Allen wrenches (10 or 12 inches long)
- Pipe bender (1/4" and 1/8")
- O.R.M. diaphragm wrench (NAD S000085 A)
- 3mm allen wrench for mounting Vapor Vaporizers

4.0. Supplies

1. Unbrako Loctite
2. Stop Cock Grease (S4105908 A)
3. Teflon Tape (1/4" or 1/2" wide)
4. Various sizes cable ties

PERIODIC MANUFACTURERS SERVICE

Routine Inspection

This section of the Instruction Manual must be used in conjunction with the Preventive Maintenance, the Service procedures and the Parts List sections of the **NAD Service Manual.** Reference to those sections are made throughout this section.

If electronic malfunctions are detected, no repairs of individual components should be attempted. All P.C. Boards undergo a vigorous burn-in process at the factory. During the burn-in the P.C. Boards and their components are exposed to vibration, temperature variations and performance functions.

North American Drager recommends that P.C. Boards are replaced instead of being repaired. An exchange program for undamaged and complete P.C. Boards is available through North American Drager Technical Service Department.

Routine Inspection Procedure

As each procedure of the Preventive Maintenance is completed, enter the serial number (when applicable) and a check mark in the appropriate box of the Preventive Maintenance Check List. The procedure numbers correspond with the number on the check list.

1.0. **Sphymomanometer Test**

Follow procedures 1.0 to 1.4.

Symptom	Action
a) BP gauge leaks	a) Replace BP gauge 4102716 A
b) Coil tubing leaks	b) Replace coil tubing 4103084 A

2.0. **Vapor Exclusion System Test**

Follow procedures 2.0 to 2.7.

Symptom	Action
a) More than one vaporizer can be turned on	a) Adjust exclusion system See Service Procedure 3.7.1.0.

3.0. **High Pressure Test**

Follow procedures 3.0 to 3.8.

Symptom	Action
a) Pressure drops faster than specified	a) Check for leaks in the piping system upstream from regulator with leak detector. Check regulator for leaks and replace if necessary See Procedure 2.8.0.0.

4.0. **Oxygen Supply Pressure Failure Protection Device**

Follow procedures 4.0 to 4.6

Symptom	Action
a) Nitrous oxide or other gases are still flowing with oxygen turned off	a) Replace O.F.P. Device 4102713 A See Service Procedure 2.9.0.0.

5.0. NAD Oxygen Monitor

Follow procedures 5.0 to 5.2

Symptom	Action
a) Unit does not calibrate	a) Check electrolyte in sensor Check sensor membrane Check batteries

6.0. Oxygen Concentration Test

Follow procedures 6.0 to 6.1.5. and 6.3. to 6.3.1.

Symptom	Action
a) Test 6.3.1. does not show 50% ± 2 O_2 and 50% ± 2 N_2O concentration	a) Try different oxygen monitor Check that O_2 and N_2O are in fact actually oxygen and nitrous oxide

7.0. Flowmeter Test

Follow procedure 7.0

Symptom	Action
a) Float does not move freely	a) Clean flowtube See procedure 2.1.2.0.
b) Float does not move at full range of flowtube	b) Check adjustment of flow control knob See procedure 2.3.0.0.
c) N_2O or air flowmeter will not turn OFF	c) Check flowtube control valve 4103352 A See procedure 2.2.0.0.

8.0. Anesthesia Breathing System Leak Test

Follow procedures 8.0 to 8.12.

Symptom	Action
a) cmH_2O pressure gauge does not indicate pressure	a) Replace cmH_2O pressure gauge
b) Specifications in test 8.10. cannot be met	b) Check all gaskets and seals for deterioration
c) Manual/Automatic selector valve is leaking	c) Check that fresh gas connector is attached to fresh gas hose Check that APL valve is closed Check that CO_2 canisters are not chipped around the edge or gaskets damaged

Anesthesia Breathing System Leak Test

Follow procedures 8.0 to 8.12.

Symptom	Action
	c) Check that cam assembly locks the absorber tightly Check that dust cap is not cracked Check that valve domes are not cracked Disassemble, clean and lubricate selector valve channel with stop cock grease

At this time, the inspiratory and expiratory valves must be carefully checked. The inspiratory valve must open when gas flows from the absorber to the patient, while the expiratory valve must remain closed. The expiratory valve must open when gas flows from the patient to the absorber, while the inspiratory valve must remain closed. For safety reasons the valve assemblies cannot be interchanged. Absorber accessories, such as the minute volumeter, can only be attached to the valve for which they are designed. However gasket, the large ring nuts, valve discs, valve domes and valve dome adapters are interchangable.

9.0.

Vapor Selector Valve

Not applicable for NARKOMED 2A

10.0.

APL Valve Flow Test

Follow procedures 10.0 to 10.8.

Symptom	Action
a) Test 10.6. does not meet specifications	a) Replace APL valve 4104839 A

11.0.

Ventilator Test

Follow procedures 11.0 to 11 1 11.

Symptom	Action
a) Pressure does not reach 50cm H_2O	a) Check that wing nuts of bellows dome are tight Check that all hose connections are tight Check that elbow on ventilator relief valve dome is tight
b) Bellows move up and down very slowly	b) Check for obstruction in muffler

11.0. to 11.1. **Ventilator Test**

Follow procedures 11.0 to 11. 11.

Symptom	Action
c) Bellows will not move up	c) Check solenoid See Procedure 5.10.0.0.
d) Pressure continues to rise constantly	d) Check ventilator relief valve
e) Constant minimum ventilation alarm	e) Check pressure pilot line

11.2. **Inspiratory/Expiratory Ratio Test**

Follow procedures 11.2 to 11.2.5.

Symptom	Action
a) I:E Ratio incorrect **Note:** Time inspiration from moment when bellows begin to rise until bellows begin to drop. Time expiration from moment when bellows drop until bellows begin to rise (reverse for ascending bellows)	a) Check I:E Ratio thumb wheel Replace if necessary See Procedure 5.11.0.0. Check AV-E P.C. Board Replace if necessary See Procedure 5.8.0.0.

11.3. **Frequency Test**

Follow procedures 11.3 to 11.3.1.

Symptom	Action
a) Frequency incorrect **Note:** Time frequency from moment when bellows rise until bellows begin to rise again (reverse for ascending bellows)	a) Check frequency thumb wheel Replace if necessary See Procedure 5.11.0.0. Check AV-E P.C. Board Replace if necessary See Procedure 5.12.0.0.

11.4. **Frequency Divider**

Not applicable for NARKOMED 2A

12.0. **Flow Direction Test**

Follow procedures 12.0 to 12.1.9.

Symptom	Action
a) Test 12.1.9. does not meet specifications	a) Check inspiratory and expiratory valves for sticking valve discs Replace APL valve if necessary

13.0. **Alarm Circuit Delay Test**

Follow procedures 13.0. to 13.2.

Symptom	Action
a) Alarm function cannot be silenced	a) Replace alarm channel See Procedure 5.4.0.0.

14.0. **Ventilator Pressure Monitor**

Follow procedures 14.0. to 14.20.

Symptom	Action
a) Logic alarm is activated	a) Adjust MPL switches See Procedure 5.6.0.0.
b) Pressure threshold is incorrect	b) Adjust MPL switch See Procedure 5.6.0.0.

15.0. to 17.0. **Pressure Alarms**

Follow procedures 15.0 to 17.6.

Symptom	Action
a) Logic alarm is activated	a) Adjust MPL switches See Procedure 5.6.0.0.
b) Pressure threshold is incorrect	b) Adjust MPL switch See Procedure 5.6.0.0

18.0. **Oxygen Ratio Monitor Alarm Test**

See Symptoms 19.0. a to d

19.0. **O.R.M.c. Test**

Follow procedures 19.0. to 19.10.

Symptom	Action
a) No alarm function	a) Check leaf switch adjustment Check for disconnect or leaks of nitrous oxide pilot line (33)
b) Constant alarm when N_2O is turned on	b) Check leaf switch adjustment Check for disconnect or leaks of oxygen pilot line (27)
c) Alarm on while only minimum O_2 flow is activated	c) Adjust or replace MPL switch
d) Alarm function varies and cannot be reproduced	d) Clean N_2O resistor

O.R.M.c. Test

Follow procedures 19.0. to 19.10.

Symptom	Action
e) Control function does not work	e) O.R.M.c. needs disassembly and cleaning
f) N_2O leak through bleeder hole	f) O.R.M.c. needs cleaning and lubrication See Procedure 2.11.0.0.

20.0.

Scavenger Interface

Follow procedures 20.0. to 20.9.0.

Symptom	Action
a) Reservoir bag overinflates 5cm H_2O valve opens	a) No vacuum or needle valve closed. Check vacuum adjustment and needle valve
b) Reservoir bag deflates completely, -0.5 & - 1.8cm H_2O valves open	b) Vacuum too high, adjust needle valve
c) Relief valves will not open	c) Clean or replace relief valves

23.0.

Chassis Isolation & Battery Test

Follow procedures 23.0. to .23.2.4.

Symptom	Action
a) Chassis isolation test unsatisfactory	a) See Procedure 5.7.0.0.
b) Battery power low	b) Charge battery or replace

24.0.

Oxygen Flush

Follow procedures 24.0. to 24.6.

Symptom	Action
a) Flush is considerably less than 50 l/min	a) Check constriction 4104867 see procedure 2.5.2.0.

Vapor Vaporizer Test Procedure

Follow procedures 1.0. to 4.2.

Do not attempt to calibrate, repair or trouble shoot a Vapor vaporizer

All service must be performed by North American Drager

Test Procedures and Specifications

1.0. Sphygmomanometer Test

1.1. Insert male Luer fitting of sphygmomanometer squeeze bulb-hose assembly into the female Luer fitting adjacent to the BLOOD PRESSURE label on the machine

1.2. Hand pump squeeze bulb until pressure of 200mm Hg is indicated on the sphygmomanometer gauge on the machine. Pinch hose adjacent to the Luer fitting to assure that the hose-bulb assembly is not the source of any leak

1.3. NOTE:
The decrease of pressure indicated at the sphygmomanometer gauge during the following 30 (thirty) seconds shall not exceed 10mm Hg

1.4. Attach test sphygmomanometer in series with unit to be tested. Both sphygmomanometers must have identical readings

2.0. VAPOR Exclusion System Test

2.1. Set handwheel on each VAPOR to 0 (zero) position

2.2. Adjust handwheel on Halothane VAPOR to any setting above 0 (zero) % volume concentration

2.3. With Halothane VAPOR set as above, it shall not be possible to adjust the handwheel on the Enflurane VAPOR or Isoflurane VAPOR

2.4. Set Halothane VAPOR handwheel to 0 (zero) position and repeat 2.2. and 2.3. with Enflurane VAPOR adjusted to any setting above 0 (zero) concentration. At this setting it shall not be possible to adjust the Halothane VAPOR

2.5. Repeat procedure 2.2. and 2.3. for Isoflurane VAPOR

2.6. NOTE:
On VAPOR 19.1 it is necessary to depress the white 0 (zero) button when setting control knob

2.7. Re-set all VAPORs to 0 (zero) position

3.0. High Pressure Test

3.1. NOTE:
Test to be performed with each gas independently

3.2. Set ON/OFF switch to OFF position (if applicable)

3.3. Close flow control valve

3.4. Open cylinder valve until indicated pressure at cylinder pressure gauge stabilizes

3.5. Close cylinder valve

3.6. NOTE:
The decrease of pressure indicated on the pressure gauge during the following 2 (two) minutes shall not exceed 50psi

High Pressure Test

NOTE:

3.7. Test must be repeated for gases with 2 (two) yokes by moving cylinder to second yoke and inserting yoke plug into yoke which has no cylinder

3.8. Check cylinder yokes for loose or missing yoke pins

4.0. Oxygen Supply Pressure Failure Protection Device

4.1. Set oxygen flow to 1.0 l/min

4.2. Set nitrous oxide flow to 1.0 l/min

4.3. Shut oxygen cylinder valve OFF if E-cylinder is source of pressure, or pipeline valve if pipeline is source of oxygen pressure

4.4. Nitrous oxide flow must cease when the flow of oxygen has stopped

4.5. Repeat test (steps 4.1. to 4.4.) for additional gas circuit(s) on the machine

4.6. Following step 4.4., when an oxygen supply pressure alarm is incorporated into the system, shutting OFF the oxygen shall actuate the alarm, when oxygen pressure drops below approximately 30 psi

5.0. NAD Oxygen Monitor

5.1. NOTE:
A Daily Check List is contained on a card located in the battery compartment of the unit

5.2. Check battery compartment for corrosion, check sensor cord for visible damage, check sensor cord electrical connectors

5.3. NOTE:
This test applies only to NARKOMED 2A equipped with Oxymed Monitor

5.4. Turn main switch ON

5.5. Remove sensor capsule from valve dome and expose to room air

5.6. Push 21% O_2 calibration button. Calibration should be completed in 45 (fourty-five) seconds

5.7. Place sensor into valve dome adapter and turn oxygen flow to 8 l/min

5.8. Monitor should display 100% O_2 within 15 (fifteen) seconds

5.9. Check alarms according to Oxymed Operator's Manual

6.0. Oxygen Concentration Test

6.1. This test specification applies to breathing systems with the oxygen sensor mounted into the inspiratory valve. The hose terminal at the inspiration valve must be open to atmosphere. A 22mm corrugated hose, at least 2 feet long, should be attached to the inspiratory valve

6.1.1. Turn oxygen monitor ON. Meter should read 21% O_2 at room air (the main switch must be turned ON when an Oxymed Monitor is used)

6.1.2. Close APL valve

Oxygen Concentration Test

6.1.3. Turn main switch ON (AM III and NARKOMED 2)

6.1.4. Adjust O_2 flow to 8 l/min

6.1.5. NOTE:
Oxygen meter shall indicate an O_2 concentration of approximately 100% (± 2%)

6.2. This test specification applies to breathing systems with the oxygen sensor mounted at a location other than in the inspiratory valve

6.2.1. Disconnect inspiratory hose

6.2.2. Place O_2 sensor in front of fresh gas outlet (common outlet)

6.2.3. Close APL valve

6.2.4. Turn main switch ON (if applicable)

6.2.5. Adjust O_2 flow to 8 l/min

6.2.6. NOTE:
Oxygen meter shall indicate an O_2 concentration of approximately 100% (± 2%)

6.3. 50% Oxygen, 50% Nitrous Oxide Flow Test

6.3.1. Test set-up as 6.2.1. through 6.2.4. Adjust oxygen flow to 3 l/min and adjust nitrous oxide flow to 3 l/min. Oxygen monitor shall indicate 50% O_2 (± 2%)

7.0. Flowmeter Test

7.1. NOTE:
Adjust flow for each gas over the full range of its associated flowmeter(s). With an anesthesia machine supply pressure within the normal range, it shall be possible to adjust the flow over the full range of the flowmeter(s). The float within the flowmeter(s) shall freely move at all positions

8.0. Anesthesia Breathing System and Fresh Gas Delivery System Test

8.1. NOTE:
The below test specifications apply to an anesthesia breathing system without accessories, e.g., respiratory meter, filters, NARKOTEST-M, concentration measurement device, and other adapters. Test limits described below will be exceeded when accessory items are included in the test. The supplier of the accessory should be contacted for leak specifications

8.2. Close all flow control valves

8.3. Turn main switch OFF (if applicable)

8.4. Turn vaporizer(s) to 0 (zero) concentration

8.5. Short circuit inspiratory and expiratory valves with 22mm hose

8.6. Set manual/automatic selector valve to BAG (only applicable to NAD/AV Absorbers)

8.7. Close APL valve; knob must be turned fully clockwise to stop position

8.8. Attach test terminal to bag mount

8.9. Connect sphygmomanometer squeeze bulb to hose barb on test terminal

Anesthesia Breathing System and Fresh Gas Delivery System Test

NOTE:

8.10. Hand pump squeeze bulb until pressure at breathing system pressure gauge indicates pressure higher than 50cm H_2O, but not exceeding 80cm H_2O

8.11. Observe pressure drop at gauge

8.12. NOTE:
30 (thirty) seconds or longer, shall be required for a pressure decrease from 50 to 30cm H_2O

9.0. Vapor Selector Valve

9.1. If vapor selector valve is used instead of vapor exclusion system, tests 8.10. and 8.11. must be performed with vapor selector in each vapor position

9.2. Turn Halothane Vaporizer OFF. Switch vapor selector valve to Halothane Vaporizer position. Perform test 8.10.

9.3. Turn Halothane Vaporizer ON and set at any concentration above .4 volume %. Pressure will drop. Increase pressure to 50cm H_2O again

9.4. Turn vaporizer selector valve to Ethrane vaporizer position. Pressure will drop slightly and then remain constant. Set Ethrane vaporizer to any concentration. Pressure should remain constant

9.5. Repeat procedures 9.2. to 9.4. for Ethrane vaporizer

10.0. APL Valve Flow Test

10.1. NOTE:
The following test specifications apply only to absorber systems incorporating a manual/automatic selector valve

10.2. Set valve to BAG position

10.3. Short circuit inspiratory and expiratory valves with 22mm hose

10.4. Open APL valve; knob must be turned fully counterclockwise to stop position

10.5. Open O_2 flow control valve and set flow to 8 l/min

10.6. Occlude bag mount opening with thumb

10.7. Observe breathing system pressure gauge

10.8. NOTE:
Breathing system pressure gauge shall not exceed 2cm H_2O

11.0. Ventilator Test

11.1. Pressure Test (patient circuit with Y-piece required)

11.1.1. Turn main switch ON (if applicable)

11.1.2. Turn ventilator switch ON

11.1.3. Adjust O_2 flow to 3 l/min

11.1.4. Adjust frequency to 10 BPM (approximately on 6 BPM to 18 BPM gauge of pneumatic ventilator)

11.1.5. Set I:E ratio to 1:2 on AV-E (electronic ventilator)

11.1.6. Adjust tidal volume to approximately 1 (one) liter

11.1.7. Adjust flow to maximum of low zone

11.1.8. Switch manual/automatic selector valve to AUTO

11.1.9. Close 15mm outlet at Y-piece with thumb

11.1.10. Descending Bellows

System pressure gauge shall indicate a pressure in excess of 30cm H_2O when bellows stops its upward motion (NOTE: The bellows will not fully deflate) During the expiratory phase, downward movement of the bellows, the pressure in the system indicated on the pressure gauge shall decrease to approximately 2cm H_2O pressure when the bottom of the bellows reaches its resting position. The pressure in the system may drop below 0 (zero) momentarily before reaching its final condition

11.1.11. Ascending Bellows

System pressure gauge shall indicate a pressure in excess of 30cm H_2O when bellows stops its upward motion. (NOTE: The bellows will not fully inflate.) During the expiratory phase (upward movement of the bellows) the pressure in the system indicated on the pressure gauge shall decrease to approximately 2cm H_2O pressure when the top of the bellows reaches its resting position.

11.2. Inspiratory:Expiratory Ratio Test

11.2.1. Attach a test lung to Y-piece of patient breathing circuit

11.2.2. With ventilator operating as described in 11.1.1. through 11.1.7. adjust frequency to lowest indicated reading on BPM gauge, i.e.: 6 BPM on 6 to 18 BPM ventilator, 10 BPM on 10 to 30 BPM ventilator (I:E ratio 1:2 and frequency 10 BPM on electronic ventilator)

11.2.3. Using a stopwatch, time the inspiratory phase of the respiratory cycle (start of inspiratory bellows movement to start of expiratory bellows movement) Record inspiratory phase time

11.2.4. Time the expiratory phase of the respiratory cycle (start of expiratory bellows movement to start of inspiratory bellows movement) Record expiratory phase time

11.2.5. Inspiratory to expiratory phase time shall be 1:2 ± 20% e.g. at 10 BPM the inspiratory time shall be 1.6 to 2.4 seconds, the expiratory time shall be 3.2 to 4.8 seconds

11.3. Frequency (BPM) Test

11.3.1. With ventilator operating as described in 11.2.1. and 11.2.2., measure time required for one respiratory cycle (start of inspiratory bellows movement to start of next inspiratory bellows movement) Lapsed time shall be within ± 20% of calculated time: e.g. at 10 BPM calculated time equals 6 (six) seconds, tolerance range is 4.8 seconds to 7.2 seconds

11.4. Frequency Divider Test (if applicable)

11.4.1. With ventilator operating as described in 11.2.1. and 11.2.2., set ⅓ BPM switch to ⅓ BPM position

11.4.2. Measure respiratory time as described in 11.3.1. Total time shall be 3 (three) times that indicated in test step 11.3.1. with the same ± 20% tolerance

12.0. Flow Direction Test

12.1. This test specification applies to systems incorporating a ventilator and breathing system with a manual/automatic selector valve

Flow Direction Test

12.1.1. Set manual/automatic selector valve to BAG position

12.1.2. Attach bag to bag connection

12.1.3. Connect ventilator hose at Y-piece

12.1.4. Open APL valve

12.1.5. Open O_2 flow control valve and adjust flow to 3 l/min

12.1.6. Turn ventilator ON

12.1.7. Set frequency to 16 BPM

12.1.8. Set tidal volume approximately 700ml

12.1.9. Adjust ventilator inspiratory flow so that tidal volume is fully delivered within inspiratory phase time

12.1.10. NOTE:
The pressure on the breathing system pressure gauge shall neither exceed + 2cm H_2O during the expiratory phase nor go below -2cm H_2O during the inspiratory phase

12.2. This test specification applies to systems incorporating a ventilator but a breathing system with no manual/automatic selector valve

12.2.1. Connect bag to bag terminal

12.2.2. Connect ventilator hose to Y-piece

12.2.3. Proceed with 12.1.3. to end of test (above)

12.3. This test specification applies to systems not incorporating a ventilator

12.3.1. Connect resuscitator bag or bellows to Y-piece

12.3.2. Open APL valve

12.3.3. Open O_2 flow control valve and adjust flow to 3 l/min

12.3.4. Occlude air intake valve (if existing) of the bag or bellows

12.3.5. Hand squeeze resuscitator bag or bellows in the frequency of normal breathing (about 10 BPM), generating a tidal volume of approximately 700cc

12.3.6. NOTE:
Test results as described under 12.1. shall be obtained

12.3.7. NOTE:
Test procedure 12.3.1. may be performed using the ventilator of another machine in place of resuscitator bag or bellows if another machine with ventilator is available

13.0. Alarm Circuit Delay Test (where applicable)

13.1. Turn main switch of machine ON. Immediately upon turning on the main switch, the audible alarm delay function will start; it will continue for 30 (thirty) ± 5 seconds. The yellow LED, adjacent to the Sonalert alarm on the alarm panel of the machine, will be actuated during the 30 (thirty) ± 5 second delay cycle

13.2. Upon completion of the audible alarm delay described in 13.1., test the function of the manually actuated delay. The manual audible alarm delay is operated by actuating the push-button located

13.2. adjacent to the yellow LED on the alarm panel. The manual delay is also 30 (thirty) ± 5 seconds in duration and includes the LED function described in 13.1.

13.3. NOTE:
Alarm functions that occur during the course of the audible alarm delay operation are indicated by red LEDs on the alarm panel. These LEDs will continue to operate at any time that an alarm condition exists regardless of the delay. The yellow LED remaining ON after 30 (thirty) ± 3 seconds of delay is an indication of malfunction of the delay circuit in the DELAY ON mode and must be investigated

13.4. NOTE:
Actuation of the high pressure and sub-atmospheric LEDs simultaneously is indication of a system failure detected by the alarm logic circuit. This requires testing of individual pressure switches (See Service Procedure 5.6.0.0.)

13.5. NOTE:
For battery test on NARKOMED 2A follow point 23.0.13.

14.0. Ventilation Pressure Monitor (DPM II & DPM-S Test)

14.1. NOTE:
The following test specifications apply to ventilation pressure monitors incorporated into NAD Anesthesia Machines; the oxygen cylinder must be closed and the oxygen pipeline supply disconnected. The oxygen low pressure alarm will be actuated and the LEDs will oscillate during the test after the main switch has been turned ON - Restore oxygen supply pressure

14.2. The following procedures (14.2. to 17.5.) can also be performed with NAD pressure switch tester (4105465 A)

14.3. Short circuit inspiratory and expiratory valves with 22mm hose and set manual/automatic selector valve to BAG

14.4. Close APL valve

14.5. Attach test terminal to bag mount

14.6. Connect sphygmomanometer squeeze bulb to hose barb on test terminal

14.7. Turn audible alarm OFF (applicable only to NARKOMED 2, NARKOMED 2A and AM III)

14.8. Turn main switch of anesthesia machine ON (applicable only to NARKOMED 2, NARKOMED 2A and AM III)

14.9. Turn ventilator switch ON (applicable only to DRAGER AV & AV-E anesthesia ventilators in NARKOMED 2, NARKOMED 2A and AM III and interfaced on DPM & DPM-S on NARKOMED STANDARD)

14 10. Turn on monitor switch (applicable to monitors which are not integral parts of anesthesia machine, e.g. interfaced to NARKOMED STANDARD)

14.11. NOTE:
Following step 14.8. or 14.9., the ventilation pressure monitor alarm shall be actuated; audible and visual alarms cannot be silenced

Ventilation Pressure Monitor (DPM II & DPM-S Test)

NOTE:

14.12. Adjust pressure selector switch to lowest setting (5, 7.5, or 8cm H_2O)

14.13. Hand pump squeeze bulb until breathing pressure gauge indicates 10cm H_2O; alarm shall be silenced

14.14. Open relief valve at squeeze bulb to allow system pressure to decrease to 0 (zero)

14.15. NOTE:
The alarm will be reactuated 15 seconds (± 4.5 seconds) after the system pressure has decreased below the pressure set at the selector switch

14.16. Adjust pressure selector switch to 12.5. or 12cm H_2O

14.17. Repeat steps 14.11. and 14.12. Pressurize to 15cm H_2O

14.18. Adjust pressure selector switch to 25 or 26cm H_2O

14.19. Repeat steps 14.11. and 14.12. Pressurize to 30cm H_2O

14.20. Set ventilator ON/OFF switch (electronic ventilators only) to 60 (sixty) second alarm delay position. Alarm shall be delayed for 1 (one) minute

15.0. Continuing Pressure Monitor Alarm Test (if applicable)

15.1. Test set-up is as described under 14.0 Ventilation Pressure Monitor Test

15.2. Hand pump squeeze bulb until breathing pressure gauge indicates 20cm H_2O (20cm H_2O on DPM-S and NARKOMED 2A)

15.3. NOTE:
Maintaining this pressure, the alarm shall be actuated after a period of 10 (ten) seconds
3 seconds

16.0. High Pressure Monitor Alarm Test

16.1. Test set-up is as described under 14.0 Ventilation Pressure Monitor Test

16.2. Hand pump squeeze bulb until breathing pressure gauge indicates 65 to 70cm H_2O; the high pressure alarm shall be actuated

16.3. NOTE:
During this test, the Continuing Pressure Monitor Alarm may be actuated if a pressure higher than 12.5cm H_2O, respectively 15 or 18cm H_2O, is maintained in the system for a period longer than 10 (ten) seconds

17.0. Sub-Atmospheric Pressure Monitor Alarm Test

17.1. Test set-up is as described under 14.0 Ventilation Pressure Monitor Test, however, the squeeze bulb is connected directly to the test terminal, eliminating spiral hose and bleed valve at bulb

17.2. Open APL valve

17.3. Hand squeeze bulb, engage in squeezed condition

17.4. Occlude intake port of bulb with thumb

Sub-Atmospheric Pressure Monitor Alarm Test

17.5. Release bulb quickly

17.6. NOTE:
The pressure in the system shall drop below -10cm H_2O for an instant and actuate the sub-atmospheric alarm; if this result is impossible to obtain, other means shall be applied, e.g. using a large syringe, or NAD pressure switch tester

18.0. Oxygen Ratio Monitor Alarm Test

18.1. Turn main switch ON (applicable only to NARKOMED 2, NARKOMED 2A and AM III)

18.2. Turn monitor switch ON (applicable only to monitors which are not integral parts of an anesthesia machine, e.g. attached to NARKOMED STANDARD or NARKOMED COMPACT)

18.3. Set N_2O flow to 3.5 l/min

18.4. Adjust O_2 flow to 500cc/min flow

18.5. Increase O_2 flow

18.6. NOTE:
The oxygen ratio monitor alarm shall be silenced with an oxygen flow of 950cc/min to 1.2 l/min (See also procedure 3.3.0.0.)

19.0. O.R.M.c. Test (Oxygen Ratio Monitor Control)

19.1. Open pipeline supply valves for oxygen and nitrous oxide

19.2. Attach oxygen monitor sensor to adapter on inspiratory valve; attch 22mm breathing hose to inspiratory valve port

19.3. Set stick shift lever on manual/automatic selector valve to BAG position (applicable only on machines with NAD/AV absorber)

19.4. Close APL valve

19.5. Turn main switch of machine ON

19.6. Open oxygen flow control valve; set flow to 0.8 l/min

19 7. Open nitrous oxide flow control fully to stop position (dont't force flow control valve)

19.8. With conditions as described in 19.6. and 19.7., the oxygen monitor shall indicate 28 ± 3% oxygen

19.9. Repeat steps 19.6 and 19.7 with oxygen flow set at 1.5 l/min and 3.5 l/min respectively. Oxygen monitor reading shall continue as described in 19.8.

19.10. Decrease oxygen flow to 0.8 l/min, nitrous oxide flow shall decrease accordingly maintaining the 28 ± 3% reading indicated in 19.8. (see also procedure 3.10.0.41.)

20.0. Scavenger Interface Maintenance

20.1. Remove cap of negative pressure relief valve

20.2 With needle-nose pliers, carefully remove valve disc assembly by turning counterclockwise

Scavenger Interface Maintenance

20.3. **NOTE:**
Do not puncture or bend disc with tips of pliers

20.4. Carefully remove lint and dirt from valve disc assembly by using a small brush

20.5. Blow residual dust from disc and spring with a low flow of air (not to exceed 5 l/min at 50 psi)

20.6. Be careful not to change spring tension while cleaning disc assembly

20.7. Install valve disc assembly in scavenger interface housing by turning clockwise

20.8. Install cap

20.9. Repeat procedure for positive pressure relief valve and second negative pressure valve (applicable only on scavenger interface with 3 [three] valves)

21.0. Accessory Attachment

21.1. Attach each accessory item to its intended location. Reject any item which cannot be properly attached

22.0. Visual Inspection

22.1. Inspect all surfaces of the equipment. Replace labels, foot pads, or other damaged parts as necessary

23.0. Chassis Isolation and Battery Test (applies only for NARKOMED 2A)

23.0.1. Test Equipment Micronta Multimeter 22-191 (Radio Shack) or equivalent

23.0.2. Chassis Voltage Test (Set Multimeter to 20 VDC)

23.0.3. Disconnect hospital medical gas supply, turn all E-cylinders OFF and depressurize anesthesia system

23.0.4. Plug power cord into 117 VAC electric outlet

23.0.5. Turn N_2O/Air selector switch to N_2O position (when applicable)

23.0.6. Turn main switch ON

23.0.7. Turn ventilator switch ON

23.0.8. Turn flowmeter lights ON (when applicable)

23.0.9. Turn all NAD monitors ON which are directly connected to the power supply (when applicable)

23.0.10. Connect the Multimeter negative probe (black) to pin 2 (signal ground) and the positive probe (red) to pin 3 (positive lead) of the Oxymed Power Outlet. The Multimeter must indicate between 9 VDC and 13.5 VDC (see schematic SKOB032)

23.0.11. Leave the negative probe of the Multimeter connected to pin 2 and connect positive probe to pin 1 of Oxymed Power Outlet. The Multimeter must indicate 0.0 VDC

23.0.12. Turn ventilator switch to 60 (sixty) seconds delay and repeat procedures 23.0.10. and 23.0.11.

23.0.13. Remove power cord from 117 VDC electric outlet and check if yellow LED for reserve power is activated (a short beep must be audible once every minute)

23.0.14. Repeat procedures 23.0.10. and 23.0.11.

Chassis Isolation and Battery Test (applies only for NARKOMED 2A)

23.0.15. On NARKOMED 2A equipped with O.R.M.c., turn oxygen and nitrous oxide ON and create an alarm condition

23.0.16. Repeat procedures 23.0.10. and 23.0.11.-Remove probes.

23.1.1. **Chassis Ground to Signal Ground Continuity Test** (Set Multimeter to 200 Ohms full scale)

23.1.2. Turn main switch OFF. **Do not** connect power cord to 117 VAC electric outlet

23.1.3. Connect 1 (one) probe of the Multimeter of pin 1 (chassis ground) of the Oxymed Power Outlet and the other probe to the ground pin (green) of the electric plug of the power cord. The Multimeter must indicate continuity between these 2 (two) points

23.1.4. Connect 1 (one) probe of the Multimeter to pin 1 of Oxymed Power Outlet and the other probe to pin 2. There shall be no continuity between these 2 (two) points

23.1.5. Remove Multimeter probes, turn flowmeter lights, ventilator, monitors and main switch OFF

23.1.6. Check battery power

23.1.7. Purge anesthesia system and activate oxygen flush button for 2 - 3 seconds

23.1.8. NOTE:
If the chassis voltage and continuity tests should not be satisfactory, refer to procedure 5.7.0.0. for Trouble Shooting

23.2. **Battery Test** (applies only to NARKOMED 2)

23.2.1. Turn main switch ON

23.2.2. Push battery test button. The green LED next to the battery test button must light up

23.2.3. NOTE:
If green LED cannot be activated, replace 6 VDC battery located in the battery compartment in the rear of the machine

24.0. Oxygen Flush

24.1. Purge system of all gases except oxygen

24.2. Actuate the oxygen flush by pressing the **O_2 Flush** button on the left front edge of the table top. The oxygen flush delivers an unmetered flow of oxygen direct to the common outlet. Releasing the **O_2 Flush** button must immediately shut OFF this flow

24.3. Attach a volumeter to the fresh gas outlet and press the **O_2 Flush** button. At 50 psi line pressure the oxygen flow should be approximately 50 l/min

24.4. Test oxygen concentration at inspiratory valve with oxygen monitor

24.5. NOTE:
Oxygen concentration must be 100%

24.6. Turn all controls and switch to OFF position

VAPOR VAPORIZER
TEST PROCEDURE

1.0. Calibration Verification of North American Drager Vapor Vaporizers

1.1. NOTE:
Recommended Analyzer: Riken Portable Gas Analyzer Model 18

1.2. Test Procedure

1.3. Before testing Vapor vaporizers, the following steps must be observed

1.3.1. Check that Vapor vaporizers were exposed to a constant temperature (preferably 22° C) for at least 1 (one) hour

1.3.2. Vaporizer must be turned OFF

1.3.3. Fill vaporizer with correct anesthetic until liquid level can be noticed above the minimum liquid level indicator

1.3.4. Turn all gases OFF

1.3.5. Turn oxygen flow to 10 l/min to flush entire system of residual gases

1.3.6. Reduce oxygen flow to 4 l/min

1.4. Calibrate gas analyzer as per manufacturer's instructions

1.5. Purge analyzer thoroughly of residual gases and anesthetic agents

1.6. Connect sampling T between common outlet and fresh gas hose

1.7. Slowly adjust Vapor vaporizer to be tested to 1.0 volume % concentration and wait 5 (five) minutes before testing

1.8. NOTE:
Be careful not to exceed the 1.0 volume % concentration calibration mark. If the handwheel is turned pass the 1.0 volume % mark, return handwheel to correct setting and wait for at least 10 (ten) minutes before checking the calibration

1.9. Slowly turn handwheel to 2.5 volume % concentration. Follow procedure 1.7. for 2.5 volume % concentration

1.10. Slowly turn handwheel to 4.0 volume % concentration. Follow procedure 1.7. for 4.0 volume % concentration

1.11. Turn vaporizer OFF and purge analyzer thoroughly before testing the next Vapor vaporizer

1.12. NOTE:
Never test a Vapor vaporizer by starting with high volume % concentrations and then decrease to lower settings

2.0. Tolerances

Halothane: ±10%
Enflurane: ±15%
Isoflurane: ±15% of respective volume % concentration setting

2.1. An additional 5% variation must be considered because of the gas analyzer's own tolerance

3.0. Conversion Factors (for Riken Gas Analyzer)

Halothane x 1.0
Enflurane x 1.08
Isoflurane x 1.07

4.0. Repeating Calibration Verification Tests

4.1. It is important that all calibration verification tests are performed under the same identical conditions as previous tests. Different vaporizer temperatures, handwheel settings, waiting periods between readings, gas analyzers and even different persons performing the calibration verifications tests will greatly effect the final test results

4.2. NOTE:
It is very important to detect gradual increases or decreases of volume % output from one test to the next, provided that identical test conditions were established

4.3. If a Vapor vaporizer shows a gradual increase or decrease in volume % output over a series of calibration verification tests, the Vapor vaporizer should be returned to North American Drager for a general overhaul. A statement describing the problem must accompany the unit

5.0. Transport of Vapor vaporizer

5.1. Before removing the vaporizer from the mount. the following procedure must be followed

5.1.1. Drain vaporizer completely

5.1.2. Remove filler and drain plugs

5.1.3. Turn handwheel to maximum concentration setting

5.1.4. Turn oxygen flow to 10 l/min for at least 20 (twenty) minutes

5.1.5. NOTE:
This procedure must be performed in a well ventilated area without personnel present

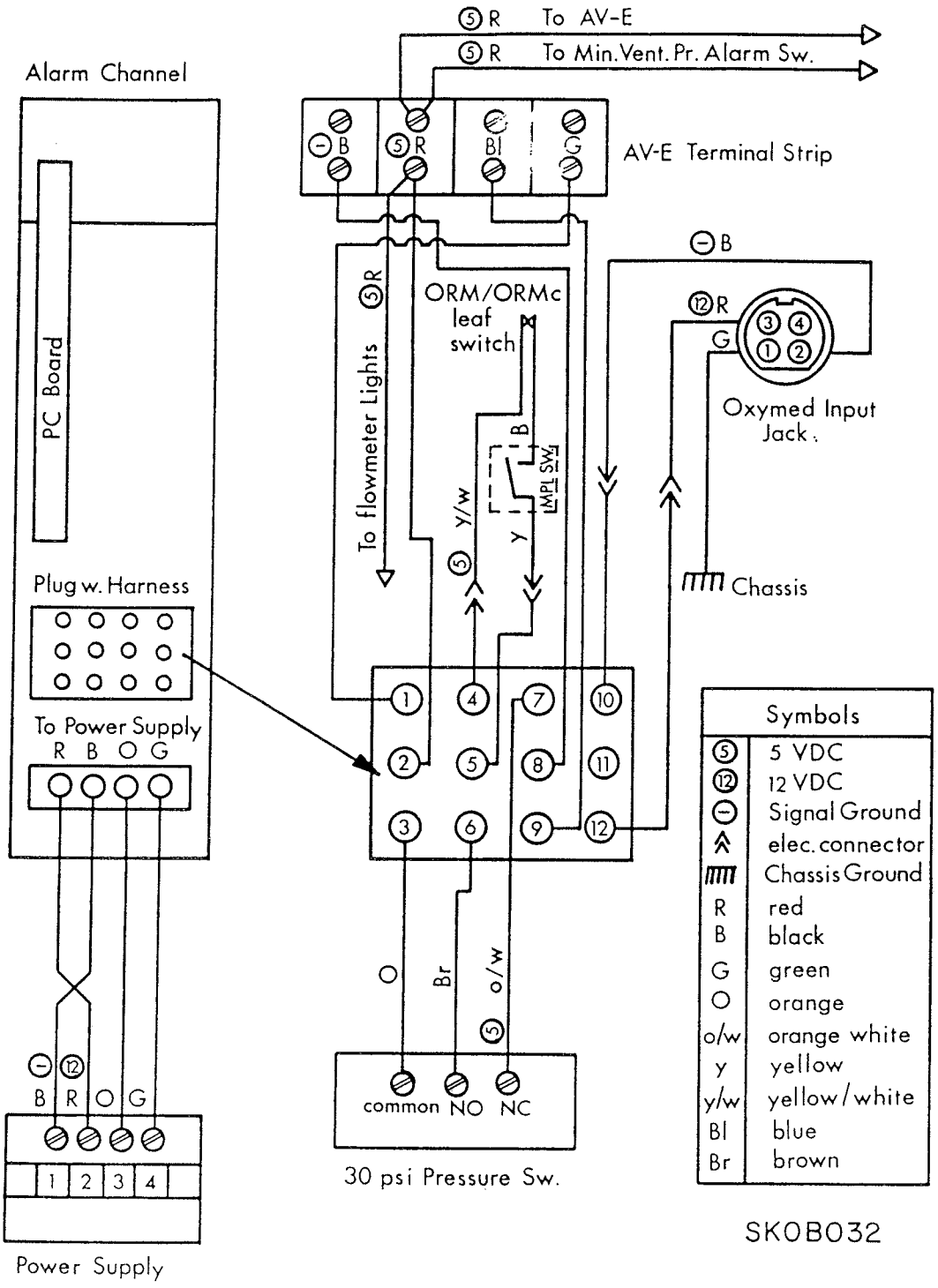
5.1.6. Turn handwheel to 0 (zero) and replace filler and drain plugs

5.1.7. Turn oxygen flow OFF

5.1.8. Remove Vapor vaporizer from mount

5.2. Package vaporizer very carefully for shipment

WIRE HARNESS
NARKOMED 2A



Tab 2

NAD CO_2 ABSORBER SYSTEM

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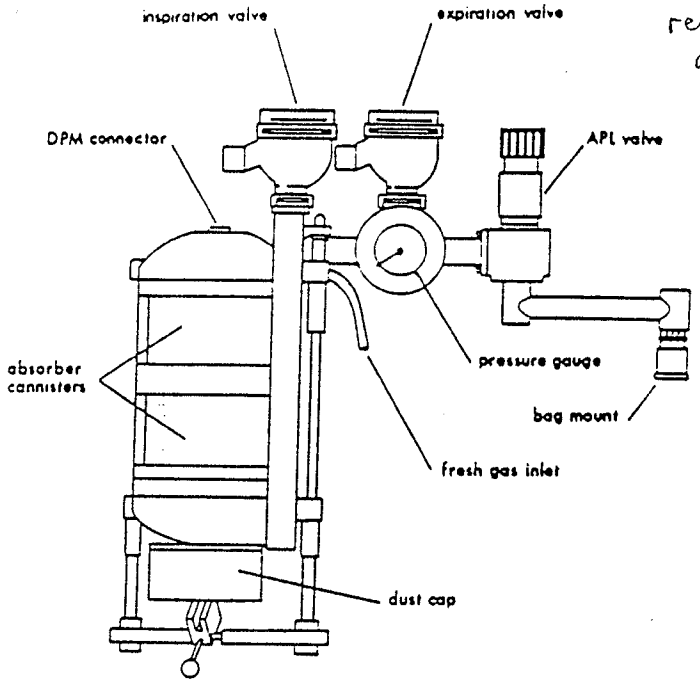
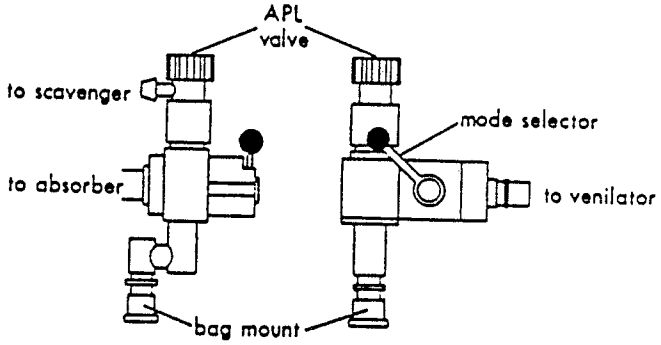
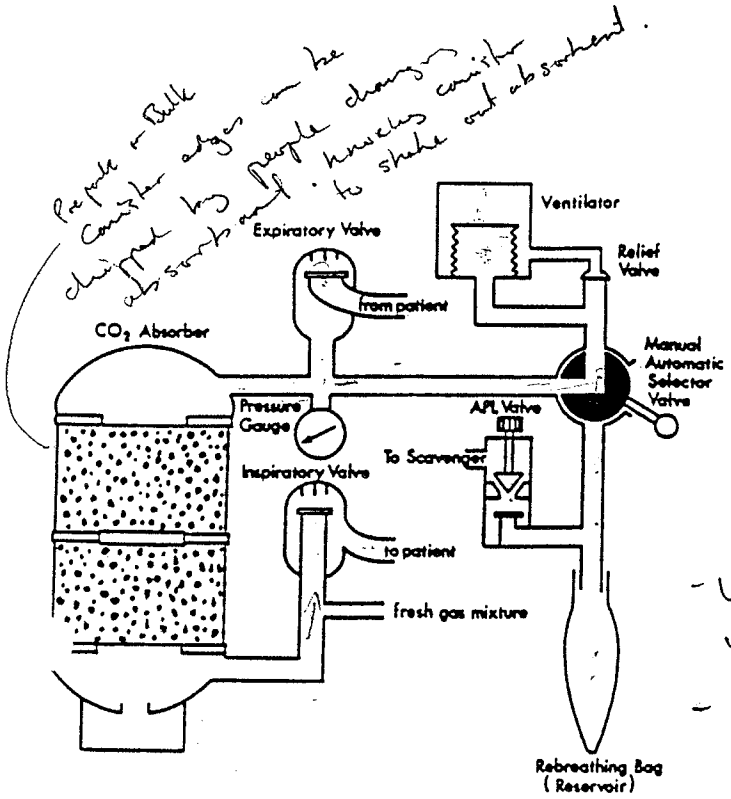
IF aspiratory valve sticks or leaks flow reverse is displayed. valve will be



CO_2 ABSORBER SYSTEM

MANUAL/AUTOMATIC SELECTOR VALVE





Two type of valves - Mica + Ceramic

Mica - deteriorates over time, flakes etc potential for aspiratory pneumonia
- 4 to 6 month life
$19 each

ceramic - not available yet but approx $80

PATIENT BREATHING SYSTEM

- valve disks can be replaced or repaired with inappropriate materials ie plastic

CO_2 ABSORBER SYSTEM

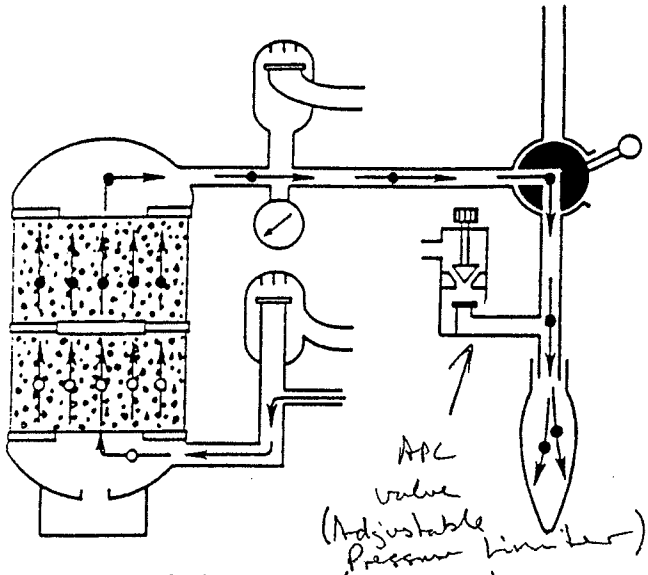
The purpose of the absorber system is to direct inspired and expired gases to and from the patient through unidirectional valves without allowing the patient to rebreathe his own exhaled carbon dioxide (CO_2). A breathing (reservoir) bag allows for accumulation of gases during expiration but also compensates for pressure changes in the breathing circuit. The inspiratory pressure is controlled by the adjustable pressure limiter (APL) valve and can be observed on the absorber pressure gauge.

MANUAL/AUTOMATIC SELECTOR VALVE

This valve is only required when a ventilator is being used instead of a breathing bag. When switched to ventilator mode the function of the breathing bag and the APL valve are eliminated while the ventilator with the automatically controlled relief valve become part of the patient breathing system.

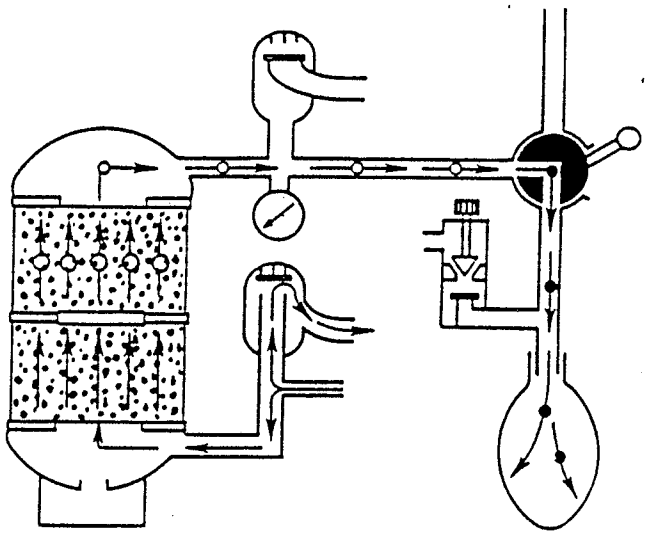
PATIENT BREATHING SYSTEM

The patient breathing system shows the CO_2 absorber with inspiratory and expiratory valves as well as fresh gas inlet and pressure gauge. The manual/automatic selector valve is shown in the ventilator mode, by-passing the breathing bag and the APL valve.



fresh gas mixture (100% oxygen)
exhaled gas with CO_2
exhaled gas without CO_2

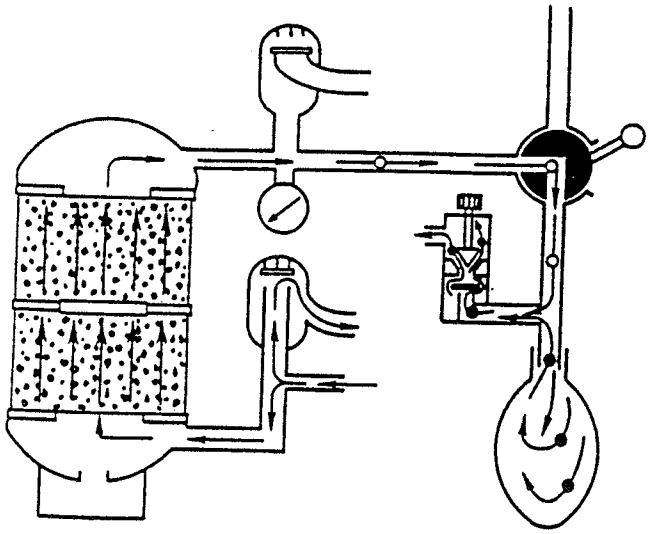
OXYGEN FLUSH
Step 1



fresh gas mixture (100% oxygen)
exhaled gas with CO_2
exhaled gas without CO_2

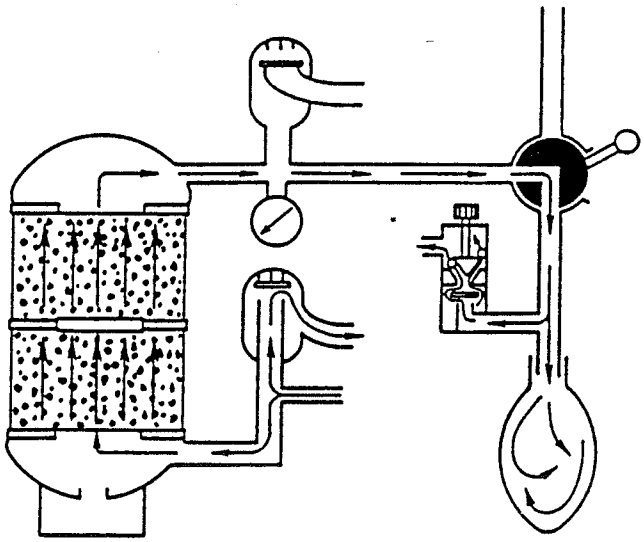
OXYGEN FLUSH
Step 2

happens on order of milliseconds



fresh gas mixture (100% oxygen)
exhaled gas with CO_2
exhaled gas without CO_2

OXYGEN FLUSH
Step 3



fresh gas mixture (100% oxygen)
exhaled gas without CO_2

OXYGEN FLUSH
Step 4

OXYGEN FLUSH (STEP 1)

Activation of the flush valve charges the patient breathing system with 100% oxygen. Exhaled gases from the previous exhalation, which are still in the absorber system, are forced towards the breathing bag. Some of the exhaled gas still contains CO_2 while gas which had already entered the CO_2 absorber does not.

OXYGEN FLUSH (STEP 2)

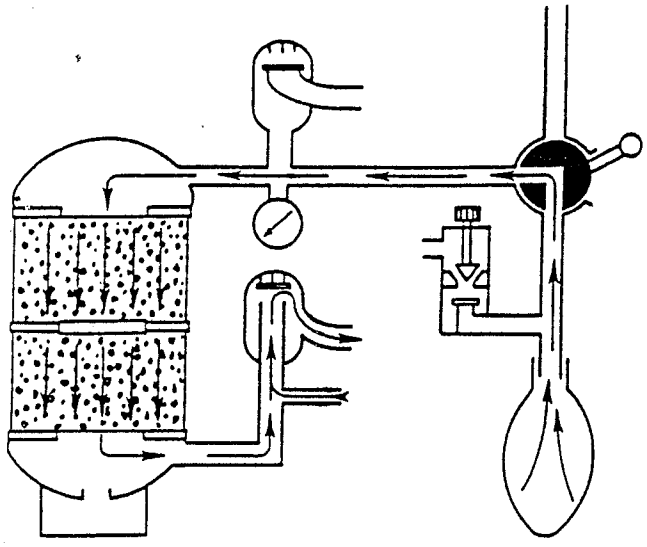
As the oxygen flush continues a minimal pressure opens the inspiratory valve while at the same time more gas is forced into the breathing bag.

OXYGEN FLUSH (STEP 3)

As the breathing bag expands, a pressure build-up in the breathing system will open the APL valve for some of the gas to escape. The opening pressure of the APL valve depends on the manual adjustment of this valve.

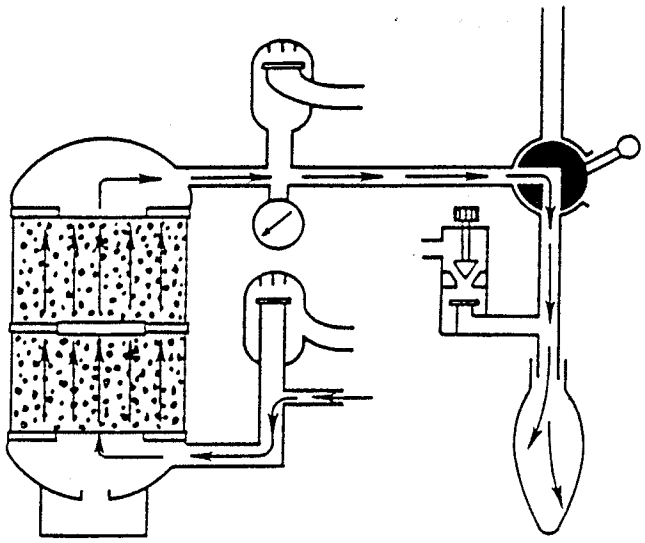
OXYGEN FLUSH (STEP 4)

Eventually all exhaled gases will be purged from the patient breathing system and be replaced with 100% oxygen. The APL valve will remain open (depending on manual adjustment) and all excess gas (100% oxygen) will be directed into the scavenger system.



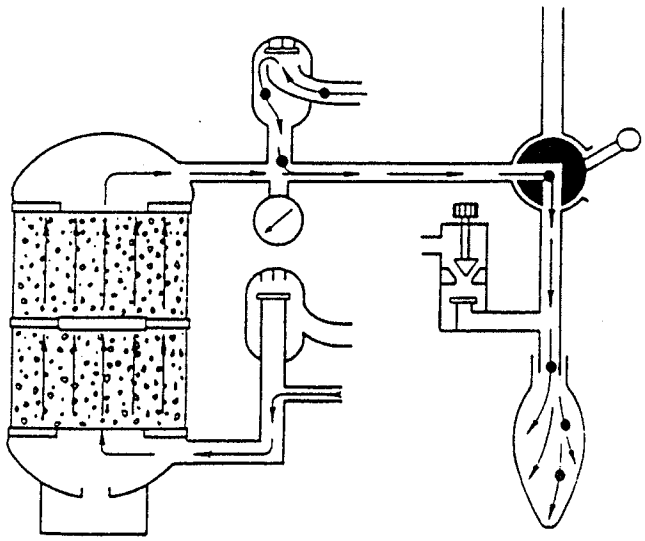
fresh gas mixture

SPONTANEOUS INSPIRATION
Step 5



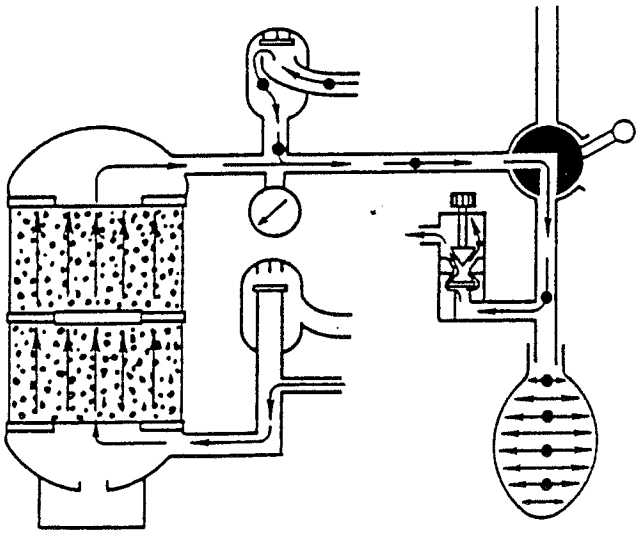
fresh gas mixture

INSPIRATORY PAUSE
Step 6



fresh gas mixture
exhaled gas with CO_2

EXPIRATION
Step 7



fresh gas mixture
exhaled gas with CO_2

EXPIRATION
Step 8

SPONTANEOUS INSPIRATION (STEP 5)

The patient is inhaling by drawing gas from the breathing bag (100% oxygen). The inspiratory valve opens, but no positive pressure develops. Since the flush valve is no longer activated, the fresh gas mixture contains oxygen, nitrous oxide and anesthetic vapor.

INSPIRATORY PAUSE (STEP 6)

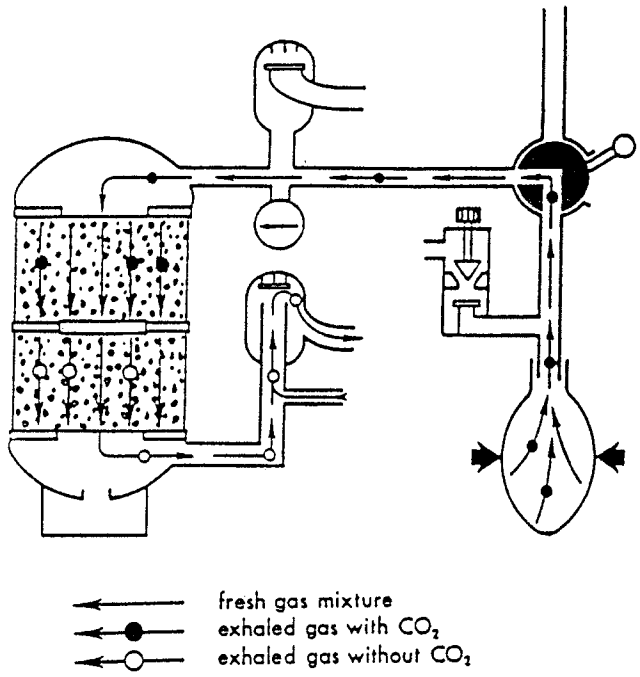
Gas flow to the patient stops just prior to exhalation. All of the fresh gas mixture is now directed towards the breathing bag. Inspiratory and expiratory valves are closed.

EXPIRATION (STEP 7)

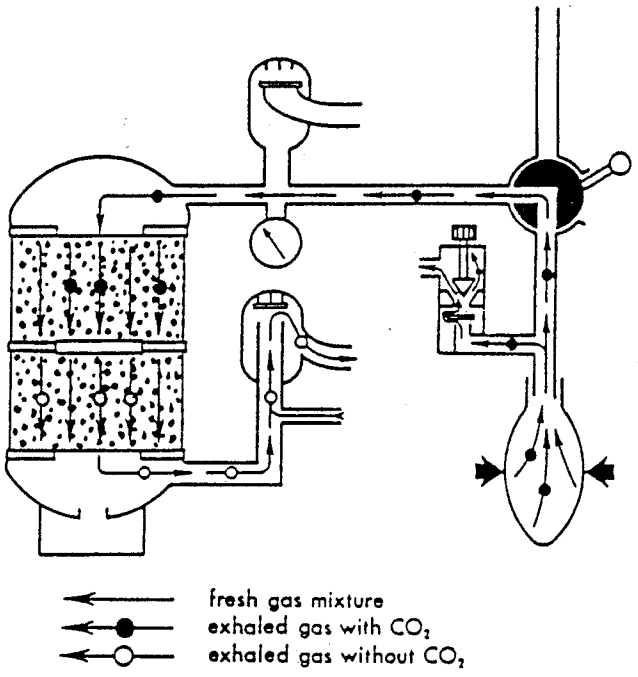
The expiratory valve opens as the patient exhales. The exhaled gas is directed to the breathing bag which begins to fill with exhaled gas containing CO_2 and fresh gas mixture.

EXPIRATION (STEP 8)

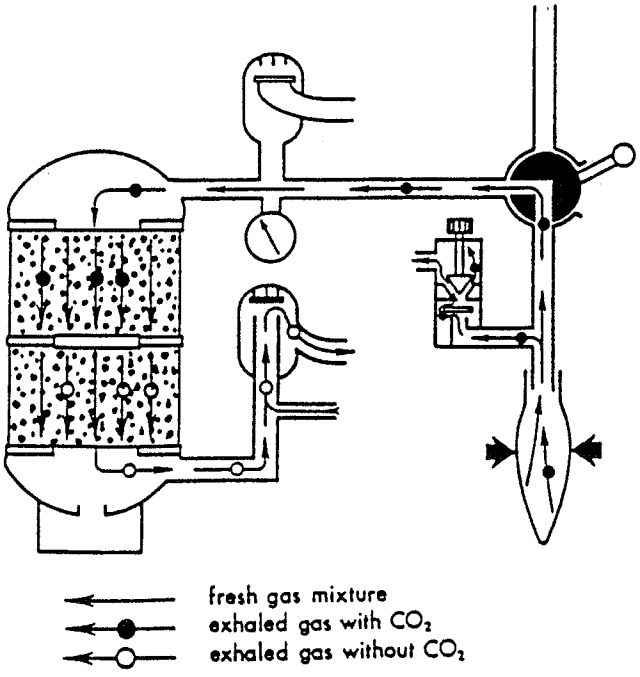
As the breathing bag fills with exhaled gas and fresh gas mixture, the pressure in the patient breathing system rises slightly and the APL valve (depending on manual adjustment) opens to allow for all excess gases (exhaled and fresh) to be directed into the scavenger system.



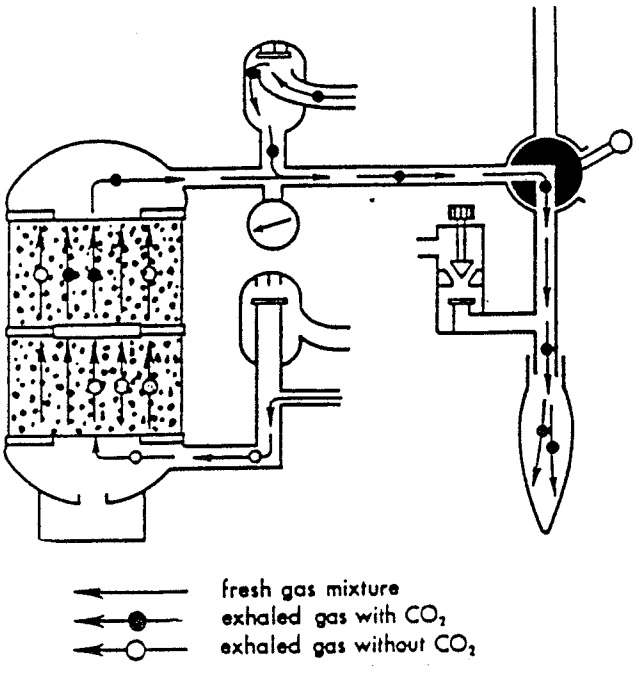
ASSISTED MANUAL VENTILATION
Step 9



ASSISTED MANUAL VENTILATION
Step 10



ASSISTED MANUAL VENTILATION
Step 11



EXHALATION
Step 12

ASSISTED MANUAL VENTILATION (STEP 9)

When the breathing bag is compressed manually fresh gas mixture and exhaled gas is forced through the absorber towards the patient. In the absorber all exhaled CO_2 is removed. As indicated on the pressure gauge, the system pressure begins to rise and the inspiratory valve opens.

ASSISTED MANUAL VENTILATION (STEP 10)

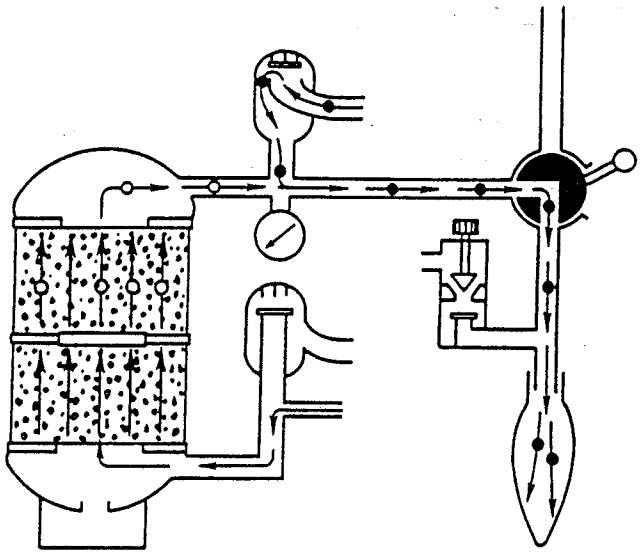
Depending on the adjustment of the APL valve, the valve will open when a certain pressure is reached by compressing the bag. Excess gases (fresh and exhaled) are directed into the scavenger system.

ASSISTED MANUAL VENTILATION (STEP 11)

Most of the gas from the breathing bag is used to assist the patient during inspiration.

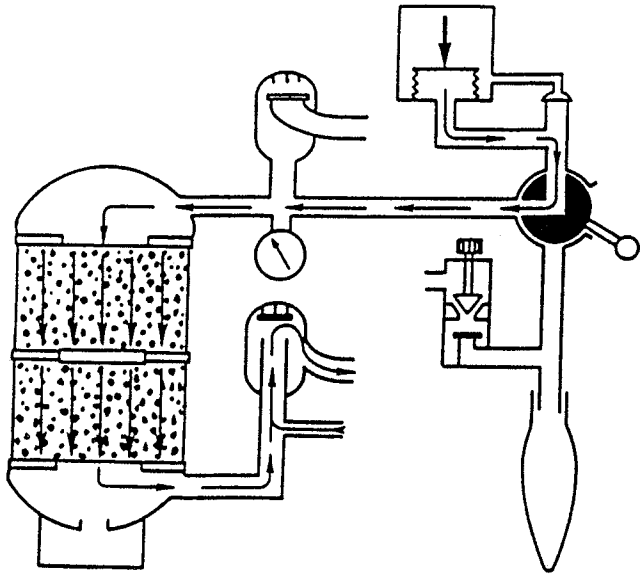
EXHALATION (STEP 12)

As expiration begins the expiratory valve opens and allows the patient to exhale. The inspiratory valve is closed and the fresh gas mixture forces the remaining exhaled gases in the absorber system towards the breathing bag. The system pressure has almost dropped to 0 (zero).



fresh gas mixture
exhaled gas with CO_2
exhaled gas without CO_2

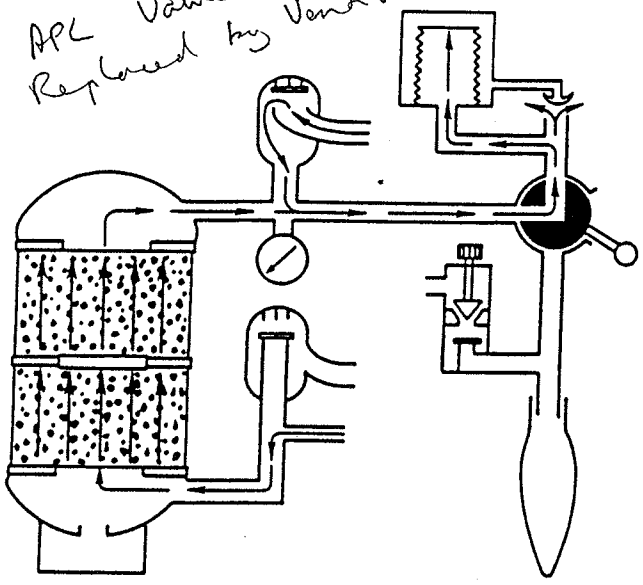
EXHALATION
Step 13



mixed gases

VENTILATOR MODE
(Inspiration)

APL Valve out of system
Replaced by Ventilator Relief Valve



mixed gases

VENTILATOR MODE
(Expiration)

EXHALATION (STEP 13)

Pressure has dropped to 0 (zero) and exhaled gases as well as fresh gas mixture are filling the breathing bag. The cycle continues with step 8.

VENTILATOR MODE (INSPIRATION)

An automatic ventilator is being used instead of manual operation. The manual/automatic selector valve is switched to ventilator mode. The breathing bag is replaced with the bellows of the ventilator. A ventilator relief valve, which automatically closes during inspiration, replaces the APL valve. Exhaled gases and fresh gas mixture air forced from the ventilator bellows to the patients. The system pressure is rising.

VENTILATOR MODE (EXPIRATION)

The exhaled gases and fresh gas mixture are directed towards the ventilator bellows. The ventilator relief valve opens automatically and excess gases are directed into the scavenger system. The system pressure has dropped to 0 (zero).

SCAVENGER INTERFACE
FOR
CENTRAL VACUUM SYSTEM

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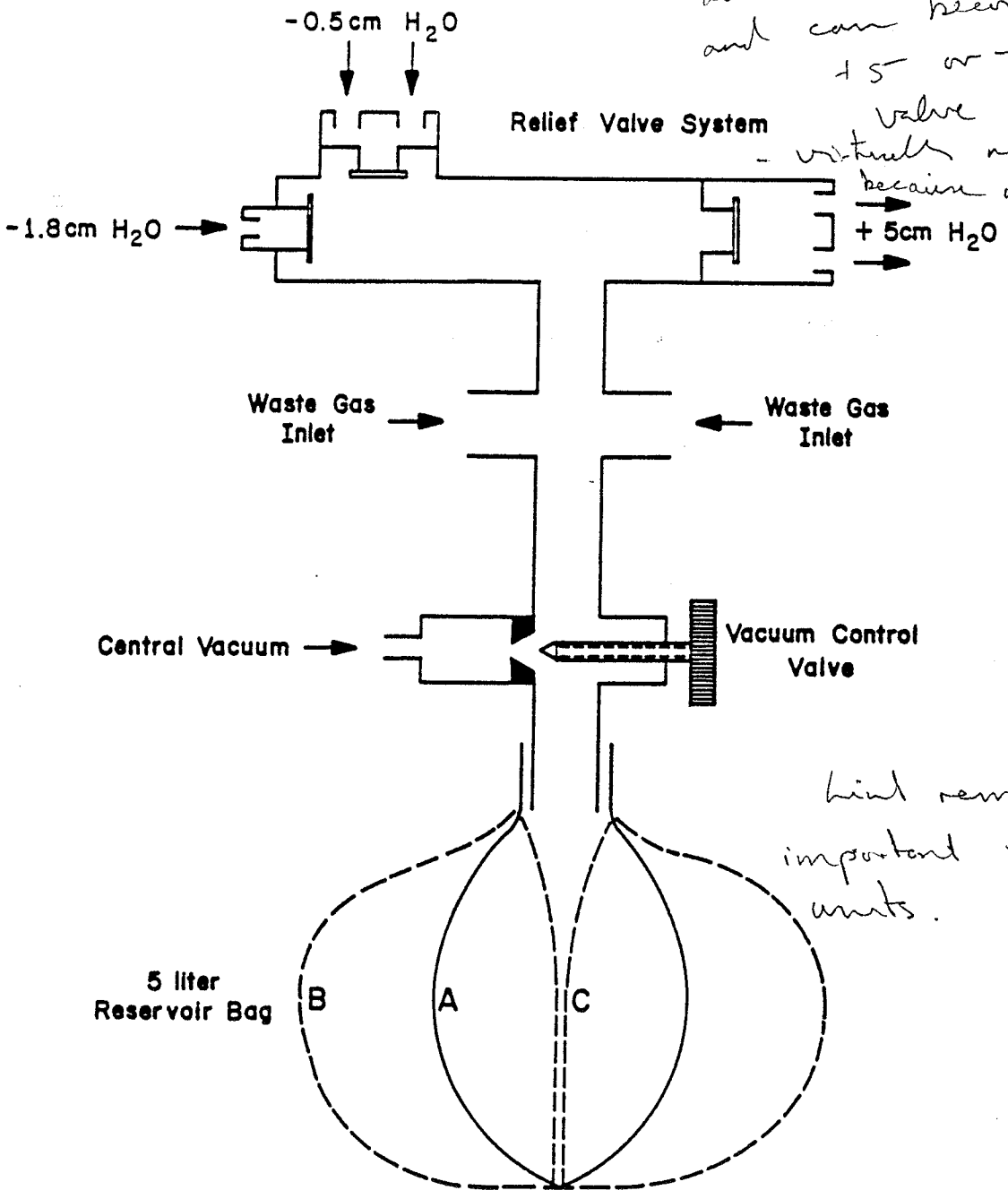
SCAVENGER INTERFACE



Valves can be assembled backward and can become + 5 or - 5 cm H_2O valve - virtually no detection because no moisture

Lint removal important for all units.

SCAVENGER INTERFACE

The Scavenger Interface for vacuum can be used in conjunction with the central hospital vacuum system (patient suction system) or with seperate vacuum system especially dedicated for the removal of waste gases.

All waste gases produced during general anesthesia are channeled via the APL valve or ventilator relief valve to the scavenger interface.

The hospital vacuum system is connected to the vacuum DISS male connector and a 5 (five) liter reservoir bag is attached to the bag mount of the scavenger interface. A control valve allows for the correct adjustment of the vacuum. The reservoir bag serves as a pressure compensator. It is important to adjust the vacuum control valve in such a manner that the reservoir bag is never overextended (B) or completely deflated (C).

Since a variable volume of waste gas is dumped into the scavenger system intermittently, while the vacuum remains relatively constant, it may be necessary to adjust the vacuum control valve during anesthesia. The reservoir bag will serve as the indicator for the correct setting, (condition A).

Exhaled humidity must not be allowed to accumulate in scavenger hoses or other parts of the scavenger system, as it may cause PEEP.

A positive pressure relief valve, which is preset at 5cm H_2O, will prevent a positive pressure build-up above this level in case the central vacuum system should fail. Waste gas will be expelled into the atmosphere if this condition occurs.

If the vacuum is set higher than necessary to evacuate the waste gas, a relief valve will allow ambient gas (air) to enter the scavenger system, when a sub-atmospheric pressure of -0.5cm H_2O is created. A back-up valve will be activated at -1.8cm H_2O, if the primary relief valve should fail.

VAPOR VAPORIZER 19.1

WARNING

THE ENCLOSED MATERIAL IS FOR INFORMATION ONLY!

NEVER ATTEMPT TO OPEN A VAPOR VAPORIZER
NEVER ATTEMPT TO CALIBRATE A VAPOR VAPORIZER
NEVER ATTEMPT TO REPAIR A VAPOR VAPORIZER
ALWAYS SEND VAPOR VAPORIZERS WHICH REQUIRE SERVICE TO
NORTH AMERICAN DRAGER TECHNICAL SERVICE DEPARTMENT

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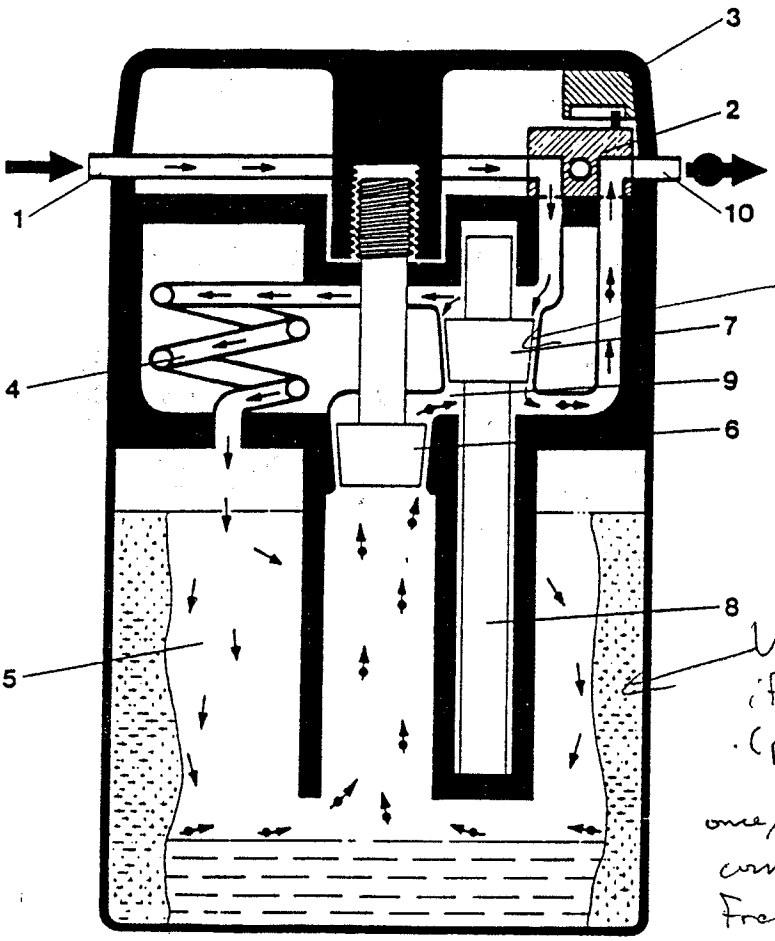
VAPOR 19.1 ($3000)



RIKEN Gas Analyzer

Wick - Problems if exposed to thymol (present in halothane)

once/month drain halothane completely, replace with fresh halothane, do again if halothane in window still looks yellow.

1. fresh gas inlet
2. turn on and turn off control (actuated by concentration knob)
3. concentration knob
4. pressure compensation (patented)
5. vaporizing chamber
6. control cone
7. vaporizing chamber, by-pass cone
8. expansion member for temperature compensation
9. mixing chamber
10. fresh gas outlet

FRESH GAS

FRESH GAS WITH ANESTHETIC VAPOR

- T-connected vaporizers very hazardous defeats many of safety interlocks etc.
- Copper Kettle very dangerous

VAPORIZER GAS FLOW

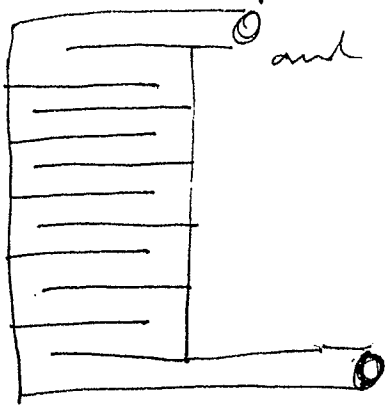
When the concentration knob (3) is in the 0 (zero) position, the ON/OFF switch (2) is closed. The gas mixture enters the vaporizer at fresh gas inlet (1) and leaves through the fresh gas outlet (10) without entering the interior of the vaporizer.

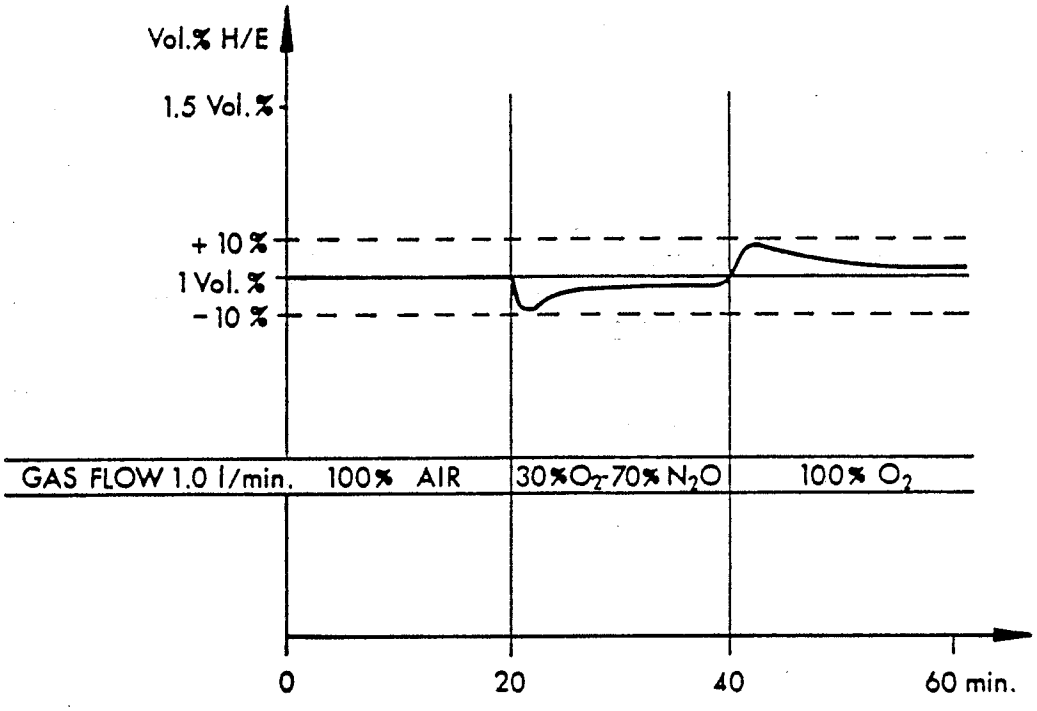
When concentration knob (3) is turned to any volume% concentration above 0.2 volume%, the ON/OFF switch (2) automatically opens and allows the fresh gas to enter the interior of the vaporizer.

The gas is immediately divided and follows 2 (two) different routes. One part of the fresh gas moves through a thermostatically controlled by-pass (7), which compensates for temperature changes and maintains the correct volume% concentration vapor output as selected with concentration knob (3). The other part of the fresh gas moves through a pressure compensator (4), which prevents pressure changes that occur upstream or downstream of the vaporizer to be transmitted into the vaporizer and thus effect the volume% vapor output. From the pressure compensator the gas continues into the vaporizer chamber (5). This chamber contains the liquid anesthetic agent which is absorbed and evaporated by a special wick assembly. As the fresh gas moves through the vaporizing chamber, it is fully saturated with anesthetic vapor. The staurated gas leaves the chamber through control cone (6). The cone is adjustable with concentration knob (3). The saturated gas and the fresh gas which did not move through the vaporizing chamber are combined and leave through fresh gas outlet (10).

The combination of the by-pass opening (7) and the control cone opening (6) determines the volume% vapor output. Other factors as discussed in the following paragraphs have also an effect on the correct vapor concentration.

Pumping Effect : Back diffusion of vapor minimized by path and dead volume




Vol.% H/E
1.5 Vol.%
+ 10 %
1 Vol. %
- 10 %
GAS FLOW 1.0 l/min.
100% AIR
30%O2-70% N2O
100% O2
0
20
40
60 min.

EFFECTS OF DIFFERENT GAS MIXTURES ON VOLUME% CONCENTRATION

All Vapor vaporizers 19.1 are calibrated with air by the manufacturer. Since most vaporizers are operated with pure oxygen or oxygen/nitrous oxide mixtures, the volume% vapor output is effected.

A Vapor vaporizer which is set to 1.0 volume% concentration at a gas flow of 1 l/min, will show the following characteristics:

GAS FLOW - AIR

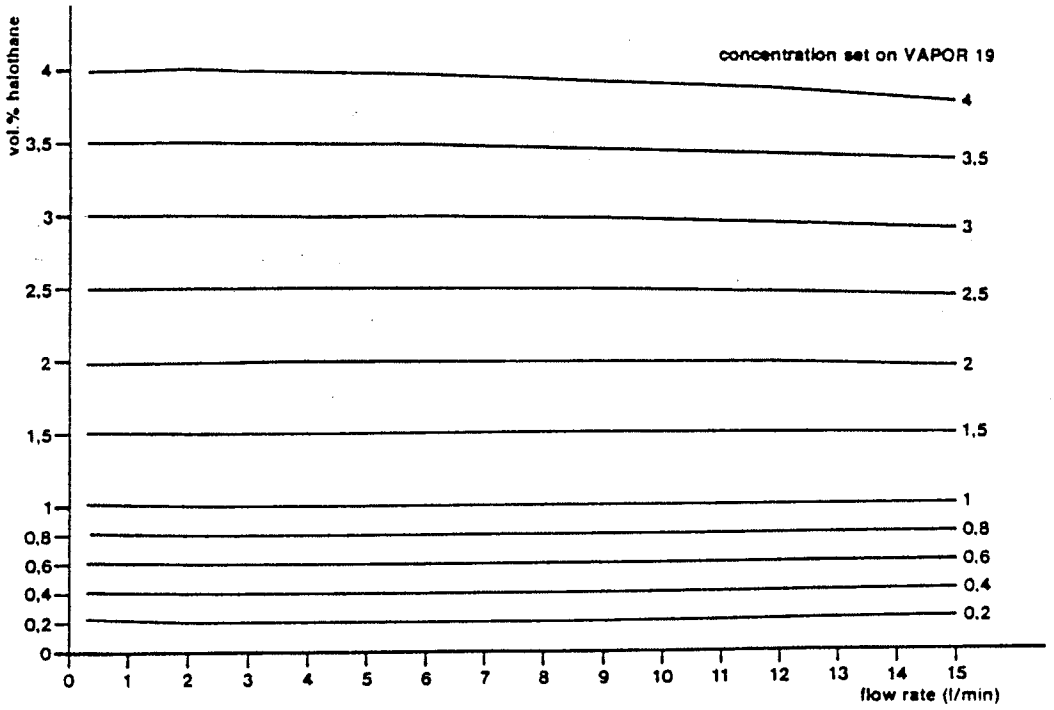
Concentration constant at 1.0 volume% output

GAS FLOW - 30% O_2 & 70% N_2O

Concentration will sharply drop and then remain slightly below 1.0 volume% output

GAS FLOW - 100% O_2

Concentration will sharply rise and remain slightly above 1.0 volume% output



Riken - Accurate to ± 5%

Spec for vaporizers ± 15% Halo, Fluoro (Isoflur)
± 20% Ethrane (Enflur)

Test: 1%, 2.5%, 4% in rising conc.

EFFECTS OF FRESH GAS FLOWRATE ON VOLUME% CONCENTRATION

While Vapor 19.1 vaporizers produce a relative constant volume% concentration at fresh gas flowrates between 2 and 10 l/min, the following observation can be made at gas flows below 2 l/min or above 10 l/min:

GAS FLOW LESS THAN 2 L/MIN

Slight increase of volume% concentration up to 1.0 volume%. Constant concentration from 1.0 to 4.0 volume% concentration

GAS FLOW HIGHER THAN 10 L/MIN

Basically constant volume% concentration up to 1.5 volume%. Gradual decrease of vapor output as volume% concentration setting is increased.

A decrease of volume% concentration between 3.0 and 4 volume% may already be noticable at flowrates of less than 10 l/min.

VAPOR VAPORIZER
TEST PROCEDURE

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1.0. Calibration Verification of North American Drager Vapor Vaporizers

1.1. NOTE:
Recommended Analyzer: Riken Portable Gas Analyzer Model 18

1.2. Test Procedure

1.3. Before testing Vapor vaporizers. the following steps must be observed

1.3.1. Check that Vapor vaporizers were exposed to a constant temperature (preferably 22° C) for at least 1 (one) hour

1.3.2. Vaporizer must be turned OFF

1.3.3. Fill vaporizer with correct anesthetic until liquid level can be noticed above the minimum liquid level indicator

1.3.4. Turn all gases OFF

1.3.5. Turn oxygen flow to 10 l/min to flush entire system of residual gases

1.3.6. Reduce oxygen flow to 4 l/min

1.4. Calibrate gas analyzer as per manufacturer's instructions

1.5. Purge analyzer thoroughly of residual gases and anesthetic agents

1.6. Connect sampling T between common outlet and fresh gas hose

1.7. Slowly adjust Vapor vaporizer to be tested to 1.0 volume % concentration and wait 5 (five) minutes before testing

1.8. NOTE:
Be careful not to exceed the 1.0 volume % concentration calibration mark. If the handwheel is turned pass the 1.0 volume % mark, return handwheel to correct setting and wait for at least 10 (ten) minutes before checking the calibration

1.9. Slowly turn handwheel to 2.5 volume % concentration. Follow procedure 1.7. for 2.5 volume % concentration

1.10. Slowly turn handwheel to 4.0 volume % concentration. Follow procedure 1.7. for 4.0 volume % concentration

1.11. Turn vaporizer OFF and purge analyzer thoroughly before testing the next Vapor vaporizer

1.12. NOTE:
Never test a Vapor vaporizer by starting with high volume % concentrations and then decrease to lower settings

2.0. Tolerances

Halothane: ±10%
Enflurane: ±15%
Isoflurane: ±15% of respective volume % concentration setting

2.1. An additional 5% variation must be considered because of the gas analyzer's own tolerance

3.0. Conversion Factors (for Riken Gas Analyzer)

Halothane x 1.0
Enflurane x 1.08
Isoflurane x 1.07

4.0. Repeating Calibration Verification Tests

4.1. It is important that all calibration verification tests are performed under the same identical conditions as previous tests. Different vaporizer temperatures, handwheel settings, waiting periods between readings, gas analyzers and even different persons performing the calibration verifications tests will greatly effect the final test results

4.2. NOTE:
It is very important to detect gradual increases or decreases of volume % output from one test to the next, provided that identical test conditions were established

4.3. If a Vapor vaporizer shows a gradual increase or decrease in volume % output over a series of calibration verification tests, the Vapor vaporizer should be returned to North American Drager for a general overhaul. A statement describing the problem must accompany the unit

5.0. Transport of Vapor vaporizer

5.1. Before removing the vaporizer from the mount, the following procedure must be followed

5.1.1. Drain vaporizer completely

5.1.2. Remove filler and drain plugs

5.1.3. Turn handwheel to maximum concentration setting

5.1.4. Turn oxygen flow to 10 l/min for at least 20 (twenty) minutes

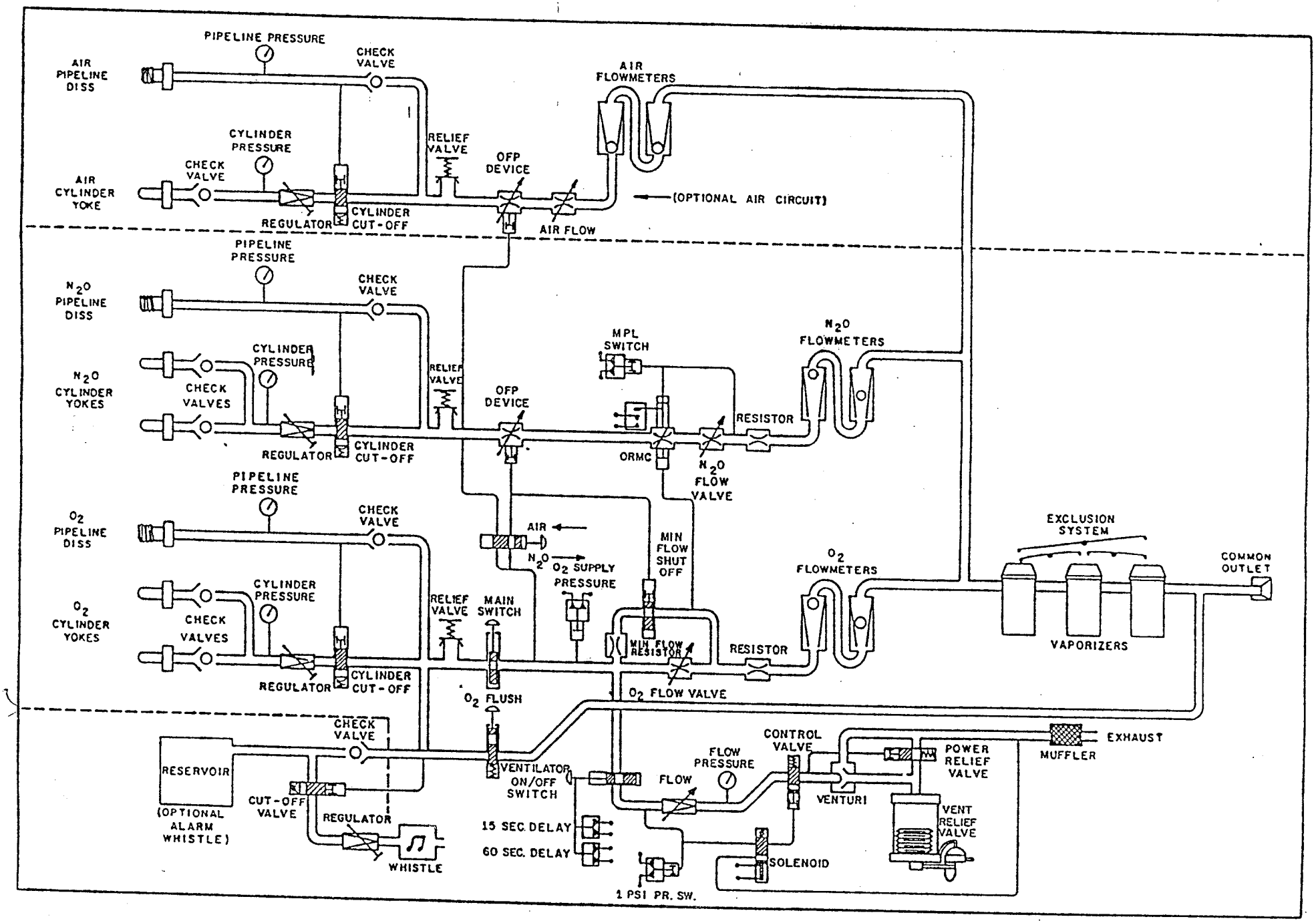
5.1.5. NOTE:
This procedure must be performed in a well ventilated area without personnel present

5.1.6. Turn handwheel to 0 (zero) and replace filler and drain plugs

5.1.7. Turn oxygen flow OFF

5.1.8. Remove Vapor vaporizer from mount

5.2. Package vaporizer very carefully for shipment



PIPING DIAGRAM , NARKOMED 2A CSA

DPM-S Test Procedure

The alarm functions of the DPM-S can be tested independently from an anesthesia gas machine. This requires a special test circuit as shown in figure II, reference point number 1. The test circuit (containing a 20 to 50 cc syringe and a -20 to +80 cm H_2O pressure gauge) must be connected to the breathing system connector in the back of the DPM-S.

Before testing the alarm functions the DPM-S toggle switch must be turned on. The main and reserve batteries must be checked as per instruction manual.

By following each step of the test procedure the alarm functions can be tested independently from each other. Use figure I as a guide for testing the alarms.

1. 0. Subatmospheric Pressure Alarm

(Push 30 second delay button to silence Sonalert, if required)

1. 1. Slowly draw the syringe plunger.

1. 2. When the negative pressure reaches -10 cm H_2O (+/-15%) on the cm H_2O pressure gauge, the LED (Light Emitting Diode) of the subatmospheric pressure alarm must be activated immediately.

1. 3. If there is a greater pressure variation than +/-1.5 cm H_2O adjust the corresponding MPL pressure switch as outlined in the "Testing and Adjustment" procedure.

2. 0. Minimum Ventilation Pressure Alarm

(Push 30 second delay button to silence Sonalert, if required)

2. 1. Set pressure selector switch to 7.5 cm H_2O. The minimum ventilation alarm LED must be activated. The Sonalert can be silenced again for 30 seconds by pushing the delay button.

2. 2. Slowly force plunger into syringe. The alarm must cancel when the pressure reaches 7.5 cm H_2O (+/-15%).

2. 3. Drop pressure to ambient by disconnecting syringe. Within 15 seconds (+/-1.5 seconds) from the time the pressure was exactly 7.5 cm H_2O the alarm shall be activated.

2. 4. If there is a greater pressure variation than +/-15% cm H_2O adjust the corresponding MPL pressure switch as outlined in the "Testing and Adjustment" procedure.

2. 5. Follow steps 2.2 and 2.3 to test 12.5 and 25 cm H_2O alarms except:

2.5.1. Set minimum ventilation pressure selector switch to 12.5 cm H_2O, respectively 25 cm H_2O.

2.5.2. Increase pressure to 12.5 cm H_2O, respectively 25 cm H_2O, before dropping to ambient.

3. 0. Continuing Pressure Alarm

(Push 30 second delay button to silence Sonalert, if required)

3. 1. Slowly force plunger into syringe until the pressure reaches 15cm H_2O (+/-15%). The continuing pressure alarm must be activated within 10 seconds (+/-1.0 seconds) of the moment 15 cm H_2O were reached.

3. 2. If there is a greater pressure variation than +/-15% cm H_2O adjust the corresponding MPL pressure switch as outlined in the "Testing and Ajustment" Procedures.

4. 0. High Pressure Alarm

(Push 30 second delay button to silence Sonalert, if required)

4. 1. Slowly force plunger into syringe until the pressure reaches 63.5 cm H_2O (+/-10%).

4. 2. The high pressure alarm LED must be activated immediately.

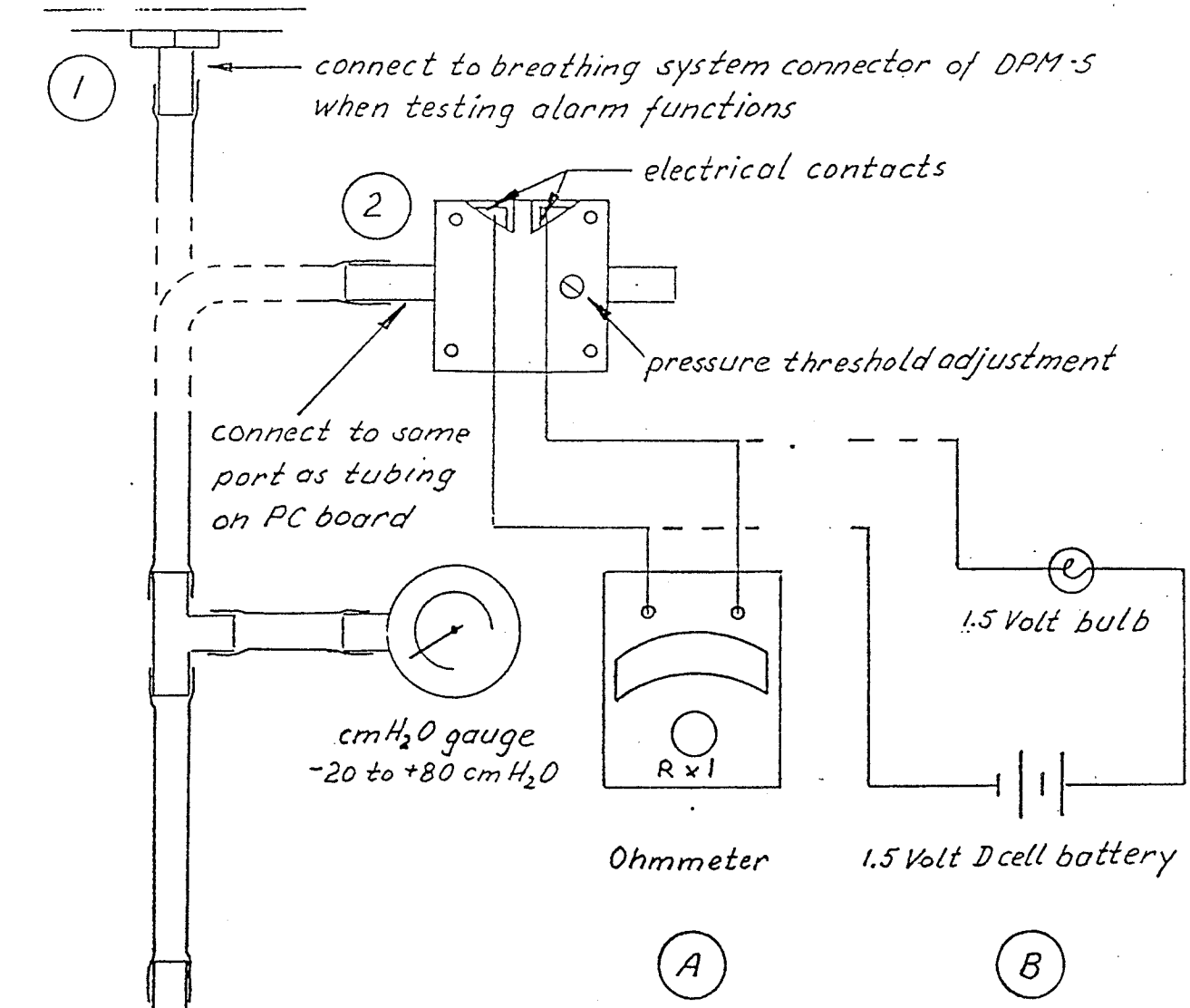
4. 3. If there is a greater pressure variation than +/-10% cm H_2O adjust the corresponding MPL pressure switch as outlined in the "Testing and Adjustment" Procedures.

5. 0. Tolerances:

10 seconds delay: +/-1.0 second
15 seconds delay: +/-1.5 seconds
30 seconds delay: +/-5.0 seconds
60 seconds delay: +/-6.0 seconds

Switches above 15 cm H_2O +/- 10%
Switches 15 cm H_2O and below +/- 15%

cm H_2O gauge should be calibrated against water column gauge to assure correct measurements.



(1) Test unit connected to breathing system connector of DPM-S to test alarm functions

(2) Test unit connected to MPL switch to test performance of pressure switch

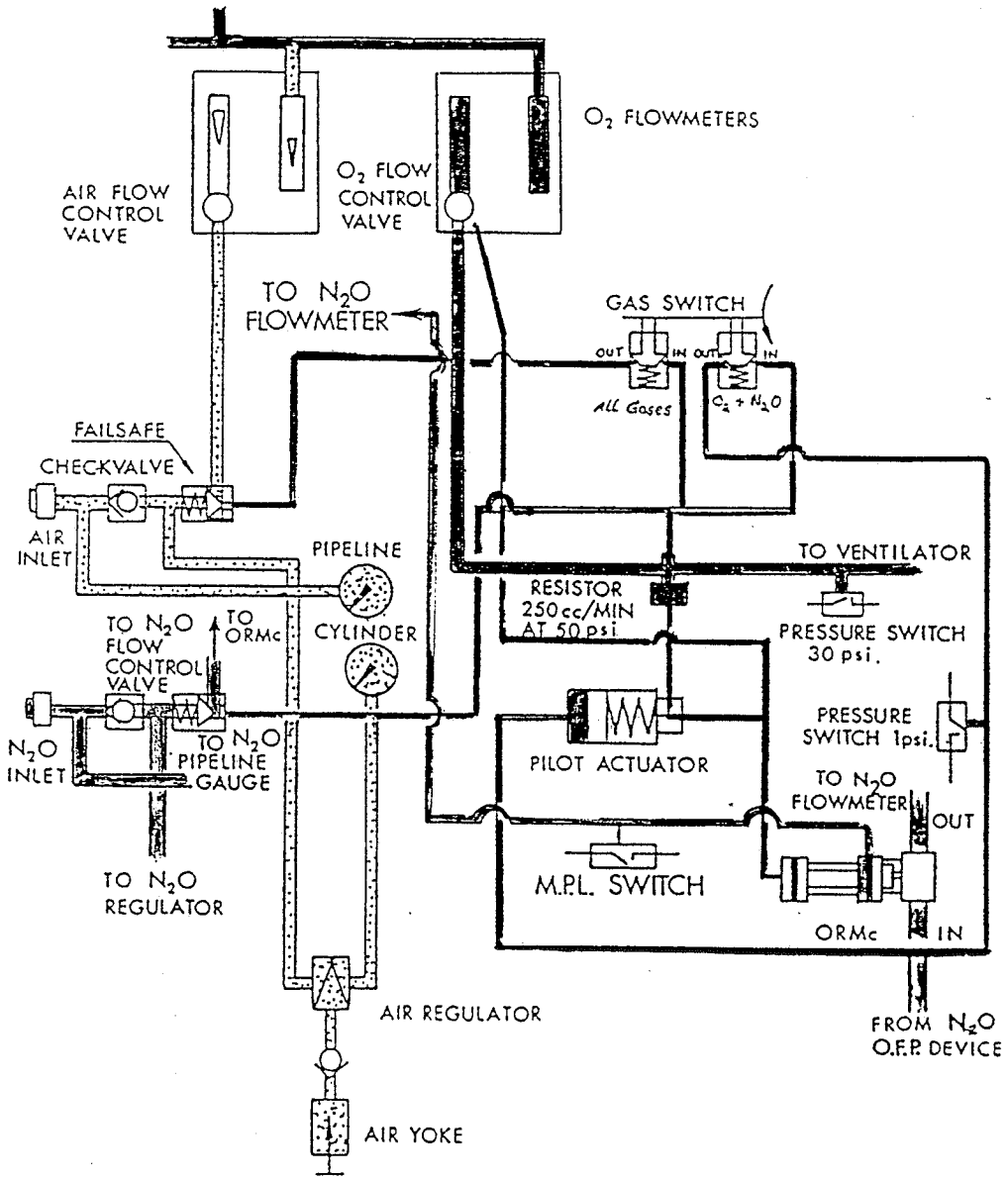
(A) Use of Ohmmeter — indicates 0 (zero) Ohms when pressure is reached

(B) Use of battery and light bulb (in lieu of Ohmmeter) — bulb will light when pressure is reached

Testing of Alarm Functions and MPL Pressure Switches

Figure II

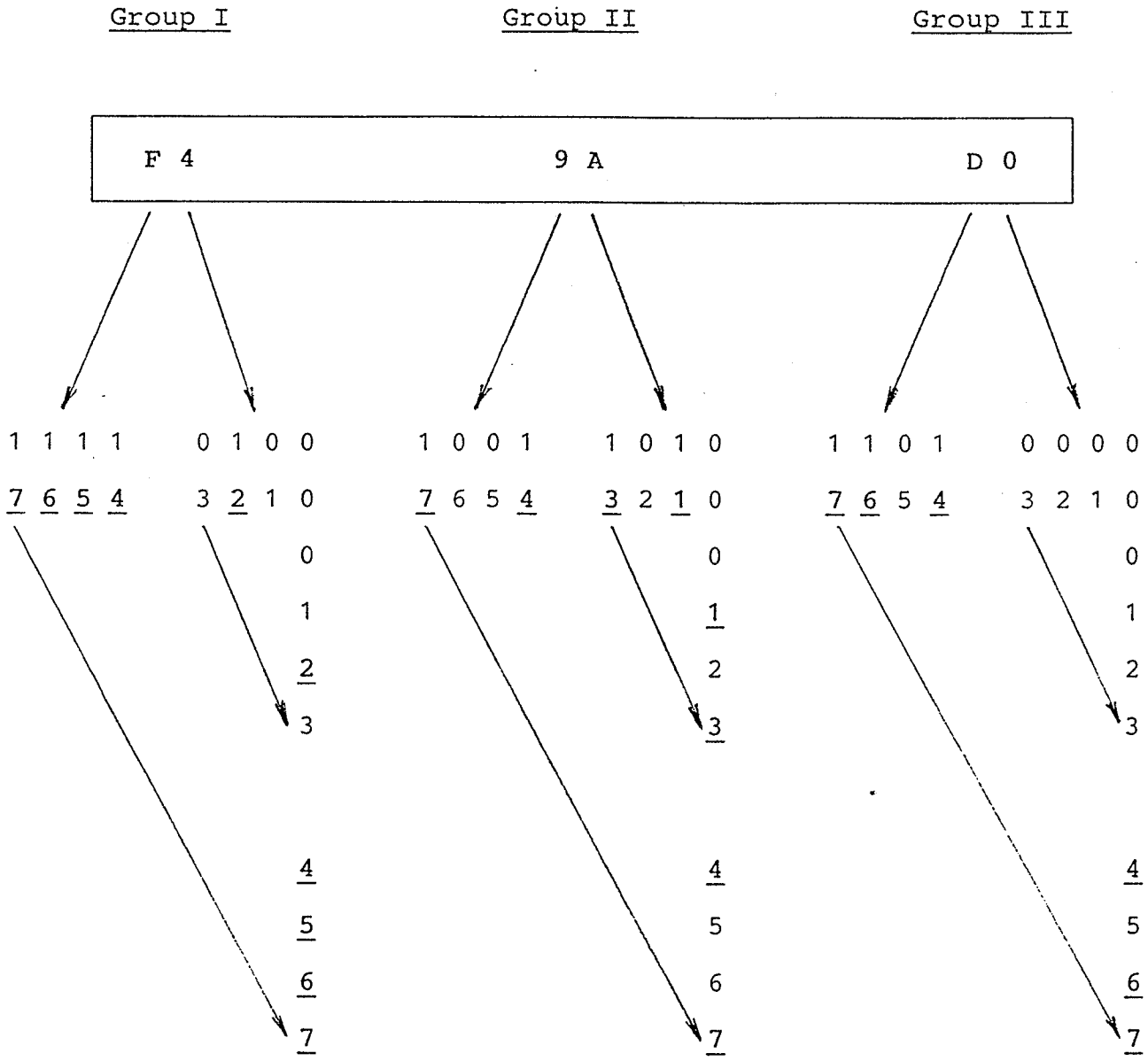
AIR ATTACHMENT, DISS/YOKE



NUMBER CONVERSIONS

	decimal				binary					hexadecimal
values	(10^3)	(10^2)	(10^1)	(10^0)	(16)	(8)	(4)	(2)	(1)	(0 - 15)
	0	0	0	0	0	0	0	0	0	0
	0	0	0	1		0	0	0	1	1
	0	0	0	2		0	0	1	0	2
	0	0	0	3		0	0	1	1	3
	0	0	0	4		0	1	0	0	4
	0	0	0	5		0	1	0	1	5
	0	0	0	6		0	1	1	0	6
	0	0	0	7		0	1	1	1	7
	0	0	0	8		1	0	0	0	8
	0	0	0	9		1	0	0	1	9
	0	0	1	0		1	0	1	0	a
	0	0	1	1		1	0	0	1	b
	0	0	1	2		1	1	0	0	c
	0	0	1	3		1	1	0	1	d
	0	0	1	4		1	1	1	0	e
	0	0	1	5		1	1	1	1	f
	0	0	3	0	1	1	1	1	0	
	0	1	0	0	(_____)					

INTERPRETATION OF HEXADECIMAL ERROR CODE



E X A M P L E

NARKOMED 2B ERROR CODE

Group I

0 - CRT controller fail (readback test)
1 - CRT memory fail (checkerboard test
2 - CRT memory fail (ROM compare test)
3 - ROM fail (firmware CRT test)

4 - System memory fail (checkerboard test)
5 - System memory fail (ROM compare test)
6 - CTC fail (timer function test)
7 - CTC fail (interrupt logic test)

Group II

0 - A/D converter fail (analog voltages out of range)
1 - Primary audio fail (speaker test)
2 - Primary audio fail (sound generation test)
3 - Backup audio fail (speaker test)

4 - Backup audio fail (sound generation test)
5 - Serial port B fail (channel A on UART)
6 - Serial port A fail (channel B on UART)
7 - Clock fail (cannot read)

Group III

0 - Clock fail (write/readback test)
1 - Clock fail (original time test)
2 - Clock fail (seconds not incrementing)
3 - Backup memory fail (checkerboard test)

4 - Backup memory fail (ROM compare test)
5 - Backup memory fail (array recall test)
6 - AC power fail
7 - Reserve power fail (battery low/diconnected)

Addendum

NARKOMED 2B/3 PERIODIC MANUFACTURER'S PROCEDURE

Canadian & U.K. MODELS

Add Procedure following Yoke Assembly:

Cylinder Supply Contents Test

1. Connect an O2 Med test adapter to the common outlet of the UUT and insert the O2 Med sensor into the test adapter.
2. Adjust the O2 flow to 4 LPM.
3. Adjust the additional gas selector switch (if applicable) to the O2 & N2O (left) position. The O2 Med shall read at least 92% O2 in 30 seconds and between 97 and 100% O2 within 1 1/2 minutes.
4. Press the O2 Med "HI" alarm limit key and a yellow LED shall activate in the corner of the key.
5. Decrement the HI alarm limit to 22% and a yellow "OXYGEN HI" LED shall activate.
6. Adjust the HI alarm limit to 100%.
7. With O2 flow at 4 LPM, adjust N2O flow to 2 LPM. The O2 Med shall indicate between 64 and 70% O2.
8. Close the O2 & N2O flow control valves.
9. Repeat cylinder supply contents test for each additional O2 or N2O yoke (if applicable).
10. Adjust the additional gas selector to the "All Gas" position (if applicable).
11. Adjust the Air flow control valve (if applicable) to 4 LPM.
12. The O2 Med shall indicate between 18 and 24% O2.

Add Procedure in lieu of O.F.P. Device:

O2 Supply Failure Test (Cylinder Supply)

1. Adjust all gas flows to 2 LPM.
2. Close the O2 "E" cylinder valve.
3. All flowmeters shall fall proportionally and indicate "0" before the O2 flow has ceased.
4. Verify the audible O2 supply failure whistle activates and continues to whistle for 7 seconds.(Canadian Models only)
5. Open the O2 "E" cylinder valve and verify that all gases return to 2 LPM +/-0.1 LPM.

Add Following High Pressure Leak Test:

Pipeline Supply Leak Test

1. Connect the UUT to the appropriate pipeline gas supplies and activate supplies.
2. Turn the UUT power switch to the STAND-BY position.
3. Turn the additional gas selector switch (if applicable) to the "ALL GAS" (right) position.
4. Close all pipeline supply shut-off valves.
5. The UUT pipeline pressure gauges shall read between 47.5 and 52.5 PSI.
6. The pipeline supply pressure shall not drop more than 2.5 PSI in 1 minute.
7. Open all pipeline supply shut-off valves.
8. Turn the UUT power switch to the ON position.
9. Adjust the O2 flow to 2 LPM.
10. Close the N2O pipeline supply shut-off valve.
11. The N2O pipeline supply pressure shall not drop more than 2.5 PSI in 1 minute.
12. Open the N2O pipeline supply valve.

Pipeline Supply Contents Test

1. With the O2 flow at 4 LPM, adjust the N2O flow to 2 LPM. The O2 Med shall indicate between 64 and 70% O2. And the O2 and N2O pipeline gauges indicate between 47.5 and 50 PSI.

2. Close the O2 & N2O flow control valves.

3. Set the additional gas selector switch to the "ALL GAS" position and adjust the Air flow to 4 LPM.

4. The O2 Med shall indicate between 21 and 24% O2.

5. Close the AIR flow control valve.

6. Activate the O2 flush button, the O2 Med shall indicate 97 - 100% O2.

7. Remove O2 monitor sensor from the fresh gas outlet.

O2 Supply Failure Test (Pipeline Supply)

1. Adjust all gas flows to 2 LPM.

2. Close the O2 pipeline supply shut off valve.

3. Observe O2 pipeline pressure gauge. The O2 supply pressure LED on the alarm panel shall activate when the O2 pressure drops between 27 and 33 PSI and a "LO O2 SUPPLY" alarm message shall appear the caution section of the central monitor display with an intermittent audible alarm.

4. All additional gas flowmeters shall fall proportionately indicate "0" flow before the O2 flow has ceased.

5. Verify the audible O2 supply failure whistle activates and continues to whistle for 7 seconds. **(Canadian Models only)**

6. Open the O2 "E" cylinder valve and verify that all gases return to 2 +/-0.1 LPM.

O2 Flush Operation Test

1. Attach an 0-80 LPM flowmeter to the fresh gas outlet.

2. Activate the O2 Flush Button.

3. The O2 flowmeter shall read between 45 and 65 LPM.

4. Remove the 0-80 LPM flowmeter from the fresh gas outlet.

5. Adjust oxygen flow on the UUT flowmeter to 2 LPM.

6. Operate oxygen flush for 10 consecutive cycles of 10 seconds each with 5 second pause between cycles. Oxygen flow on machine flowmeter shall return to 2 +/-0.1 LPM upon completion of 10 cycles.

7. Attached Vapor Key-Index fill adapter with 0-5 PSI pressure gauge to drain adapter on Vapor Key-Index. Open drain valve on adapter and set Vapor concentration knob to 2%.

8. Adjust UUT Oxygen flow to 4 LPM. Observe pressure gauge on Vapor drain and record pressure at which it stabilizes.

9. Actuate oxygen flush and hold open until pressure on Vapor gauge stabilizes. Pressure rise during oxygen flush shall not exceed 1.45 PSI. Record results of test on test report. Shut off oxygen flow and remove Vapor gauge. Set Vapor concentration to zero.

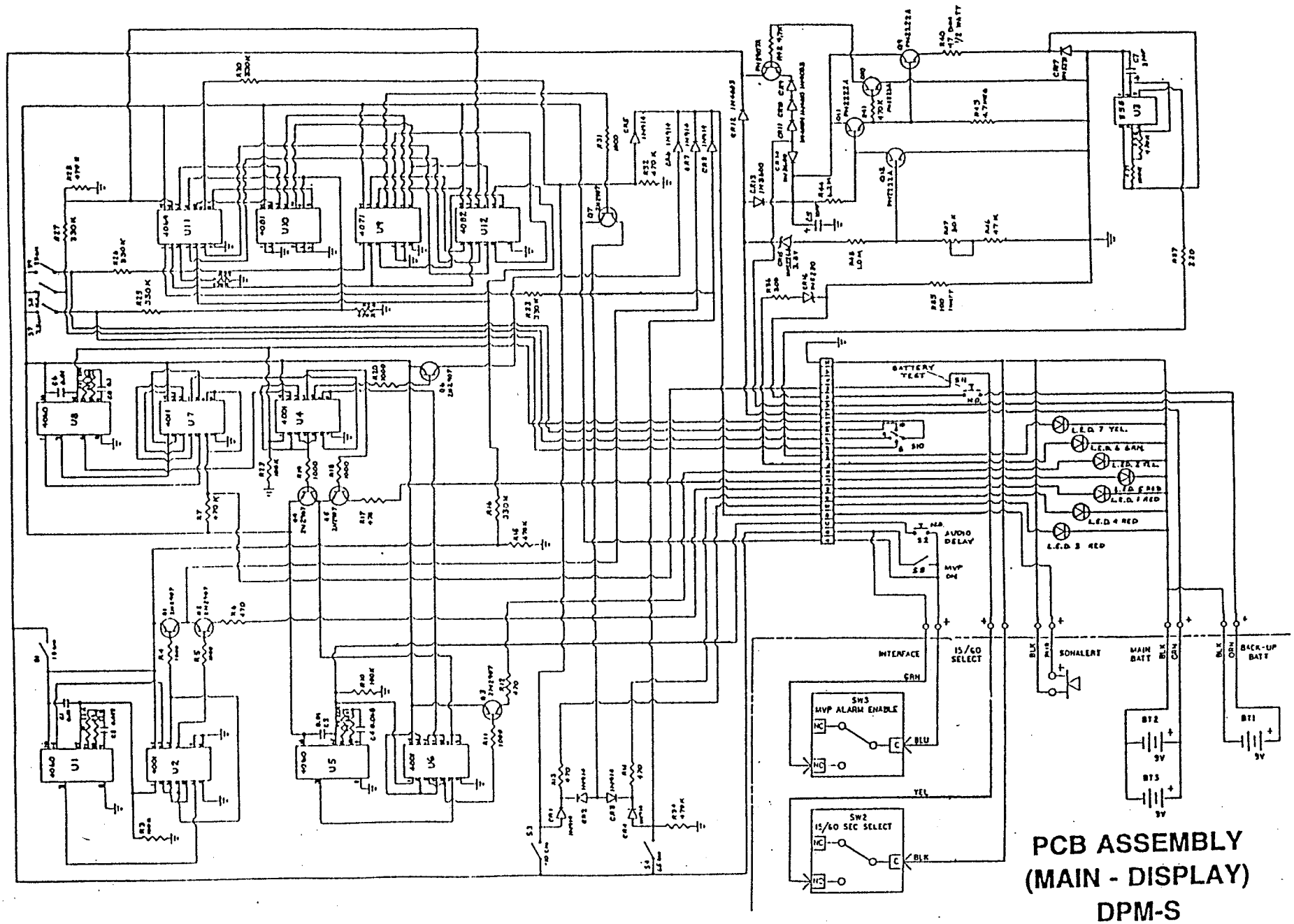
Low Pressure Test

1. Attach O2 supply to common outlet through a 0-100 ml/min flowmeter. Tee a -20 to +80 cmH20 pressure gauge between test flowmeter output and common outlet.

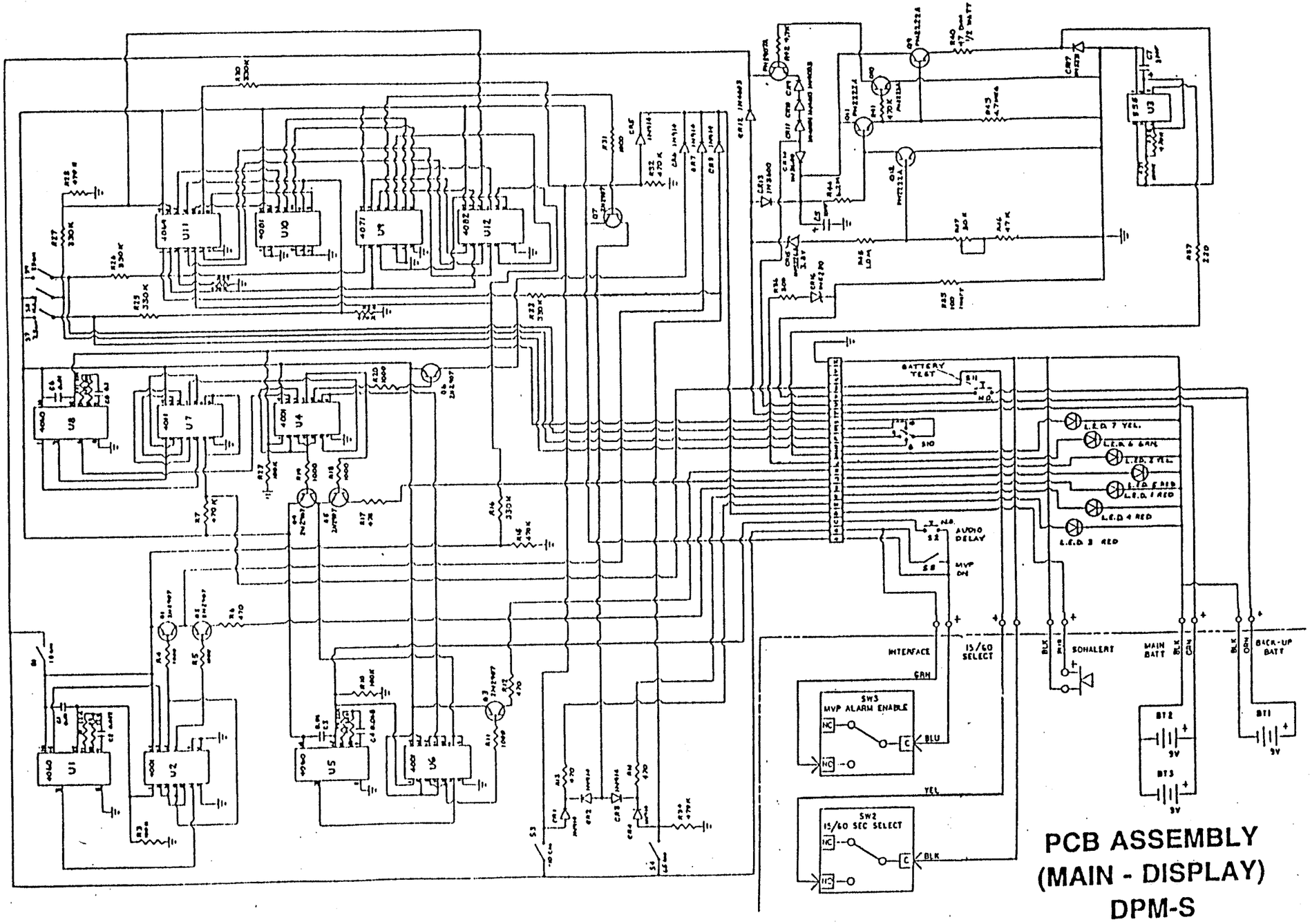
2. Close all flow control valves on anesthesia machine. Set Halothane Vapor to 2% concentration.

3. Open the O2 supply valve and adjust to 30 cmH20 on pressure gauge at common outlet. The flow through the test flowmeter shall not exceed 50 ml/min.

4. Repeat test with Enflurane and Isoflurane Vapors opened successively.



PCB ASSEMBLY (MAIN - DISPLAY) DPM-S



PCB ASSEMBLY (MAIN - DISPLAY) DPM-S

Tab 3

NORTH AMERICAN DRÄGER EDUCATION DEPARTMENT

NARKOMED 2A

BASIC TROUBLESHOOTING GUIDE

NM2A

BASIC TROUBLESHOOTING GUIDE

The information contained in this guide is for use by TSC personnel only. This information shall not be given to hospital personnel under any circumstances.

To use this guide, find the symptom which most closely matches the problem you are having. Find the symptom number on the pages which follow. Next to the symptom number, there are a list of probable causes and some simple tests to aid in isolating the source of your problem.

NOTE: The probable causes listed do not include such things as popped circuit breakers and unplugged machines. At this point, it is imperative that you ensure the machine is plugged into a live AC outlet and all breakers are pushed in.

SYMPTOMS

1. CB1 (AC power circuit breaker) pops.
2. CB2 (AC receptacles circuit breaker) pops.
3. CB3 (battery circuit breaker) pops.
4. CB4 (switched power circuit breaker) pops.
5. CB5 (unswitched power circuit breaker) pops.
6. Reserve power active LED is lit on alarm channel only (no power to Centralert and Spiromed).
7. Reserve power active LED is lit on alarm channel and Centralert displays "RES PWR ACT".
8. Reserve power low LED is lit on alarm channel and Centralert displays "RES PWR LOW".
9. Centralert and Spiromed remain on with main switch in stand-by position.
10. Centralert and Spiromed will not turn on.
11. Centralert, O2Med and Spiromed will not turn on.
12. Machine will not turn on at all.
13. Minimum ventilation pressure alarm will not activate.
14. Minimum ventilation pressure alarm will not turn off.
15. Alarm channel is not communicating with Centralert.
16. Speaker inoperative (one speaker system).
17. Centralert displays "SPEAKER FAIL" (two speaker system).
18. Centralert displays "DIAG FAULT".
19. Centralert displays "NETWORK DOWN".
20. Centralert is displaying alarms which are not actually occurring.
21. O2 sensor disconnect indication.
22. O2Med will not calibrate.
23. O2Med readings are inaccurate.
24. O2Med will not retain calibration memory.

25. Spiromed readings are inaccurate or erratic.

26. Reverse flow.

27. Self diagnostic LED is flashing red and green (any monitor).

28. Ventilator will not cycle. See Attachment 3.

29. Ventilator stuck in inspiratory phase. See Attachment 4.

#	PROBABLE CAUSES	TESTS
1.	-Defective power supply.	-Substitute known good unit.
2.	-Excessive load on receptacles.	-Total load not to exceed 10 amps.
	-Defective power supply.	-Substitute known good unit.
3.	-Defective O2Med.	-Disconnect power input to O2Med.
	-Defective alarm channel.	-Disconnect wiring to terminal 3 on power supply.
	-Defective power supply.	-Substitute known good unit.
4.	-Defective plug-in PCB.	-Substitute known good unit.
	-Defective O2Med.	-Disconnect power input to O2Med.
	-Defective power supply.	-Disconnect wiring from terminal strip.
	-Defective alarm channel.	-Substitute known good unit.
5.	-Defective Centralert, Spiromed or data loop protection PCB.	-Disconnect power input to one monitor at a time.
	-Shorted gray power cable.	-Disconnect gray power cable from power supply.
	-Defective power supply.	-Disconnect gray power cable.
6.	-Loss of AC power.	-Check wall outlet.
	-Defective power supply.	-Test for 11-15 VDC at terminal 2 on power supply.
7.	-4 pin cable to J4 of alarm channel loose or defective.	-Check connections and test for 11-15 VDC.
	-Defective alarm channel main switch microswitches.	-Check switch operation.
	-Defective plug-in PCB.	-Substitute known good unit.
	-Defective power supply.	-Test for 11-15 VDC at terminal 2 on power supply.

8.	Test battery voltage at terminal 3 on power supply. If voltage is above 11 VDC ±1, see #8A. If below 11 VDC ±1, see #8B.	
A.	-Defective plug-in PCB.	-Substitute known good unit.
B.	-Low battery. See note.	-Recharge or replace.
	-Defective alarm channel.	-Test voltage at terminals 3 and 4. Should be the same.
	-Defective power supply.	-Remove green wire from terminal 4. Terminal 4 voltage should jump to approx. 14.5 volts.
	-Defective battery.	-If above tests good, replace.
	NOTE: A severely discharged battery may require 72 hours to recharge before the reserve power low LED will go out. Machine must be plugged in.	
9.	-Gray power cable connected to power out jack.	-Connect to power in jack.
	-Defective relay in panel mount chassis.	-Remove relay temporarily.
10.	-Defective power supply.	-Test for 11-15 VDC at Spiromed power jack on power supply.
	-Gray power cable from power supply to power in jack is disconnected or defective.	-Test for 11-15 VDC at top end of cable.
	-Defective relay in panel mount chassis.	-Listen for click. Test for 11-15 VDC at relay output pin.
11.	-Wiring between J3 on alarm channel to bottom of panel mount chassis is disconnected or defective.	-Check red wire for proper connection or 11-15 VDC.
	-Defective plug-in PCB.	-Substitute known good unit.
12.	-Defective power supply.	-Test all outputs.
	-Defective alarm channel main switch microswitches.	-Check switch operation.
	-Defective plug-in PCB.	-Substitute known good unit.
	-4 pin connector going to J4 on alarm channel loose, disconnected or defective.	-Check connections and test for 11-15 VDC.
13.	-Ventilator must be turned on.	-Check ventilator main switch.
	-Improper cam operation at ventilator main switch asm.	-Check for proper operation.
	-Defective electrical switch at ventilator cam asm.	-Check with ohmmeter.
	-Defective wiring between ventilator main switch and alarm channel.	-Check red and green wires for proper connection.
	-Defective plug-in PCB.	-Substitute known good unit.

14.	-Pilot line disconnected or leaking.	-Check pilot line connections.
	-Pressure leak in alarm channel or on plug-in PCB.	-Perform pressure leak test.
	-Defective MPL switch on plug-in PCB.	-Using pressure switch tester, check pressure thresholds of MPLs.
	-Defective plug-in PCB.	-Substitute known good unit.

NOTE: If symptom is occurring with ventilator turned off, check cam asm, electrical switch and wiring as in symptom #13.

15.	-40 pin gray cable from data interface to alarm channel misconnected or defective.	-Check cable connections or substitute known good unit.
	-Defective data interface.	-Substitute known good unit.
	-Defective plug-in PCB.	-Substitute known good unit.

NOTE: If gray cable is improperly connected, damage may occur to data interface and/or plug-in PCB.

16.	-Wiring between O2Med and speaker loose, disconnected or defective.	-Check wiring and all connections.
	-Defective speaker.	-Substitute known good unit.
	-Defective monitors or data interface.	-Disconnect suspected monitor from data loop as per Attachment 2.

17.	-Defective primary speaker.	-Substitute known good unit.
	-Wiring between J6 of Centralert and primary speaker loose, disconnected or defective.	-Check all connections and wiring.
	-Defective Centralert.	-Substitute known good unit.

NOTE: Once "SPEAKER FAIL" message has been generated, machine must be turned off to reset Centralert.

18.	-Shorted audio silence button on Centralert front panel.	-Remove 2 pin plug for silence button.
	-Defective Centralert.	-Substitute known good unit.

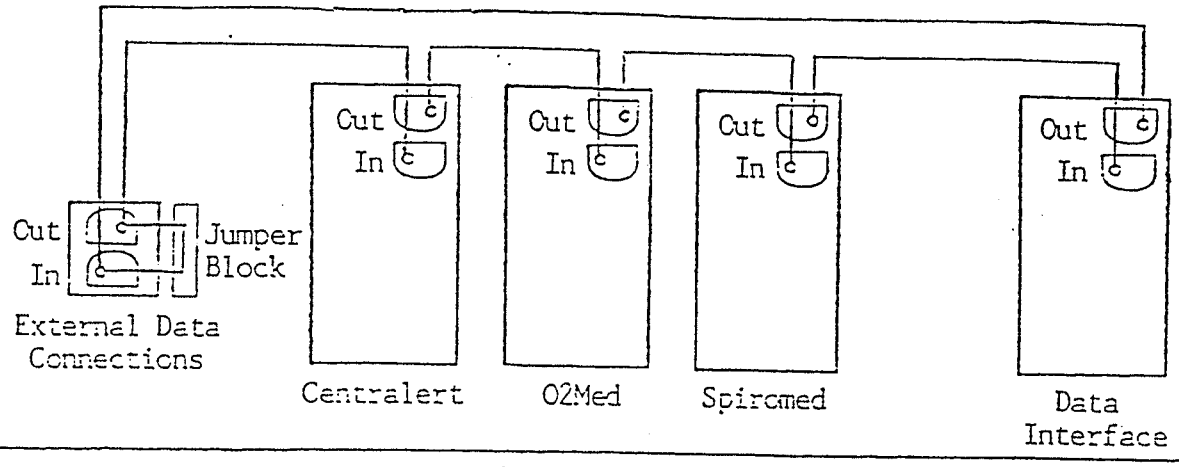
19.	-Data loop ribbon cables loose, disconnected, improperly connected or defective.	-Check cable connections as per Attachment 1.
	-40 pin gray cable between data interface and plug-in PCB loose, disconnected, improperly connected or defective.	-Check cable connections. See note under symptom #15.
	-Self diagnostic LED flashing red and green on any monitor.	-Replace monitor.
	-Defective monitor without self diagnostic LED flashing.	-Eliminate suspected monitor from data loop as per Attachment 2 example.
	-Defective data loop protection PCB (extended chassis only).	-Bypass as per Attachment 2 or substitute known good unit.
	-Data jumper block loose, missing or defective (standard chassis only).	-Check jumper block.
20.	-Same as symptom #15.	-Same as symptom #15.
	-Defective Centralert.	-Substitute known good unit.
21.	-Defective sensor cable.	-Substitute known good unit.
	-Wiring between monitor and sensor input jack loose, disconnected or defective.	-Check connections and wiring.
	-Defective O2Med.	-Substitute known good unit.
22.	-Defective sensor capsule.	-Substitute known good unit.
	-Defective sensor cable.	-Substitute known good unit.
	-Defective wiring between monitor and sensor input jack.	-Check connectors and wiring.
	-Defective O2Med.	-Substitute known good unit.
23.	-O2Med calibration error. See note.	-Recalibrate monitor to 21%.
	-Defective sensor capsule.	-Substitute known good unit.
	-Defective sensor cable.	-Substitute known good unit.
	-Defective O2Med.	-Substitute known good unit.

NOTE: When calibrating monitor to 21%, it is necessary to allow capsule enough time to stabilize. Expose capsule to 21% O2 for three minutes prior to initiating calibration cycle.

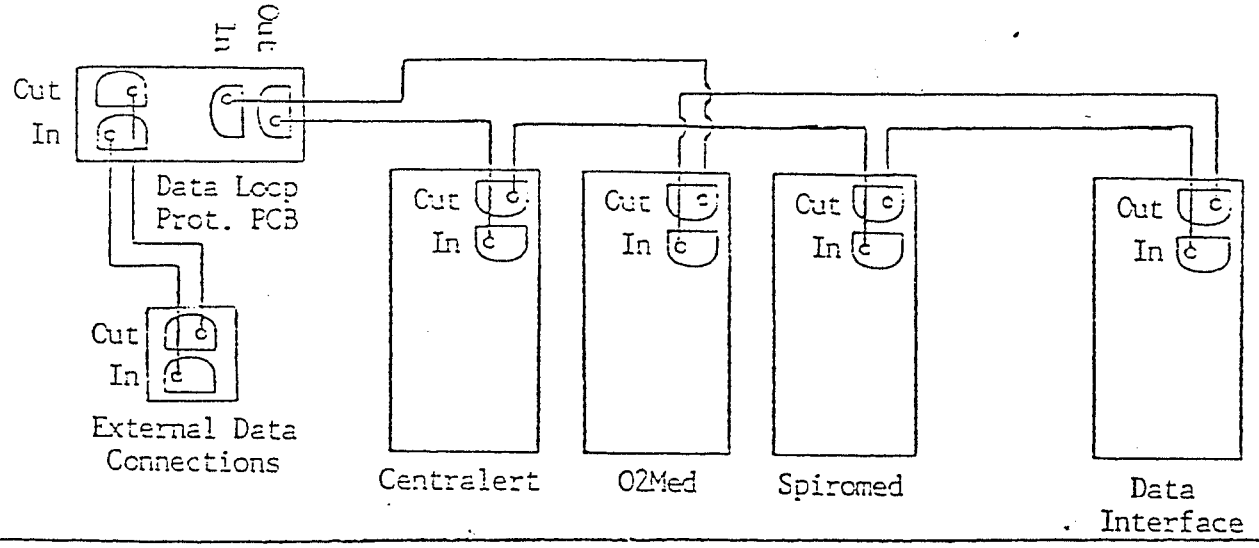
24.	-Defective battery.	-Test for battery voltage at terminal 3 on power supply.
	-Wiring between power supply and O2Med loose, disconnected or defective.	-Check wiring. Test for battery voltage at J5 pin 3 of O2Med.
	-Defective O2Med.	-Substitute known good unit.

25.	-Spiromed sensor dirty or defective.	-Clean and lubricate sensor or substitute known good unit.
	-Defective Spiromed monitor.	-Substitute known good unit.
	NOTE: Because tidal volume is affected by so many variables, it is not uncommon to see a difference between the bellows preset tidal volume and the volume displayed by the Spiromed.	
26.	-Leak between expiratory valve and Spiromed sensor.	-Inspect O-rings, valve disc, valve seat, etc.
	-Defective Spiromed sensor.	-Substitute known good unit.
	-Defective Spiromed.	-Substitute known good unit.
27.	-Internal problem with monitor.	-Replace affected monitor.

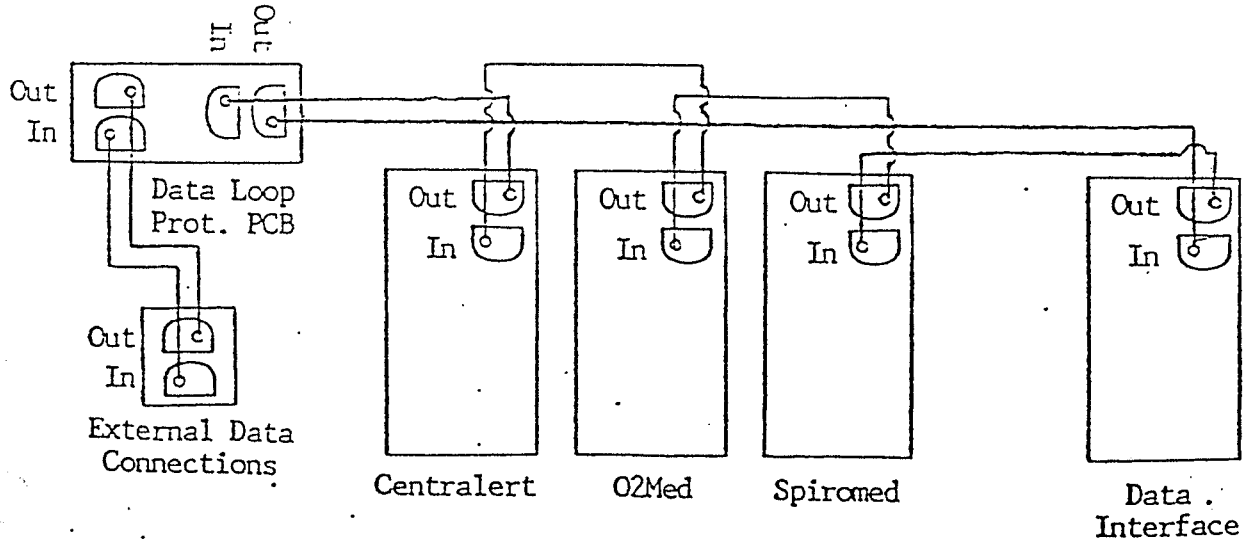
PANEL MOUNT COMMUNICATIONS NETWORK LOOP CONFIGURATIONS



STANDARD BOX
SINGLE SPEAKER

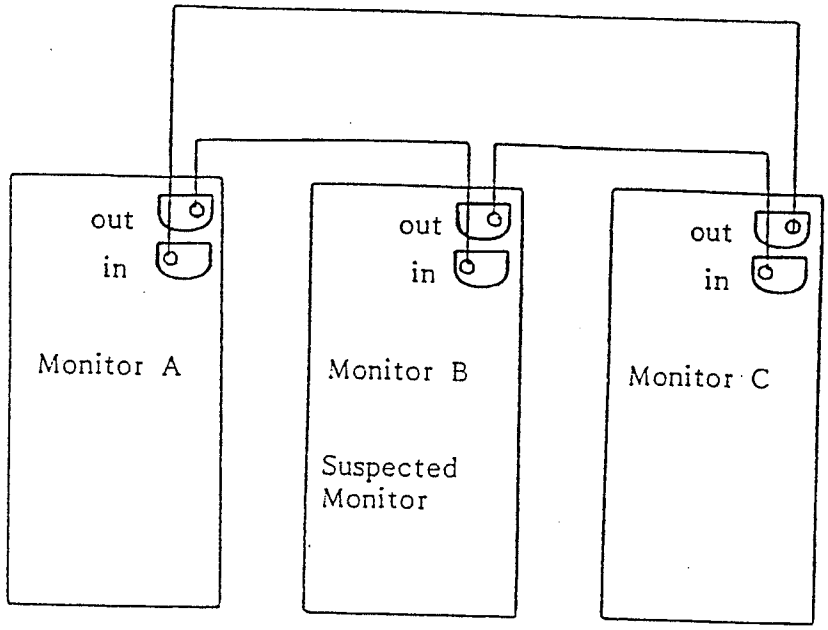


EXTENDED BOX
SINGLE SPEAKER

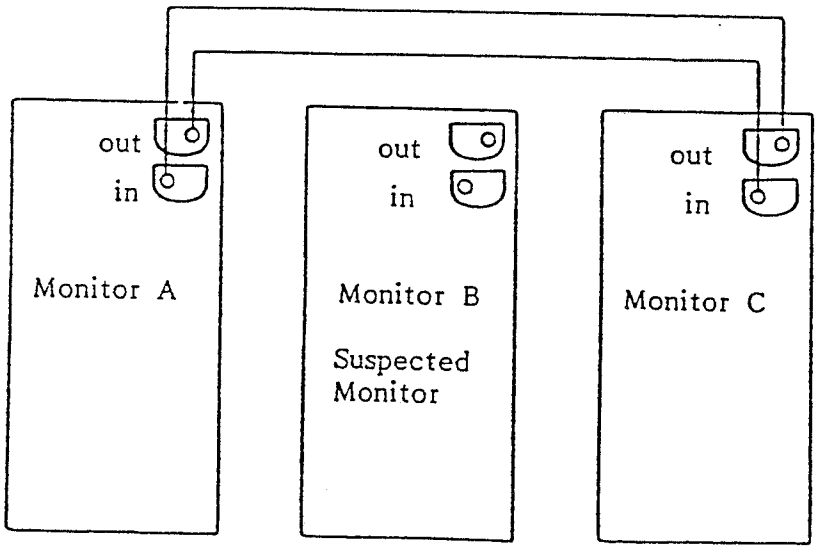


EXTENDED BOX
DUAL SPEAKER

ELIMINATING MONITOR FROM LOOP



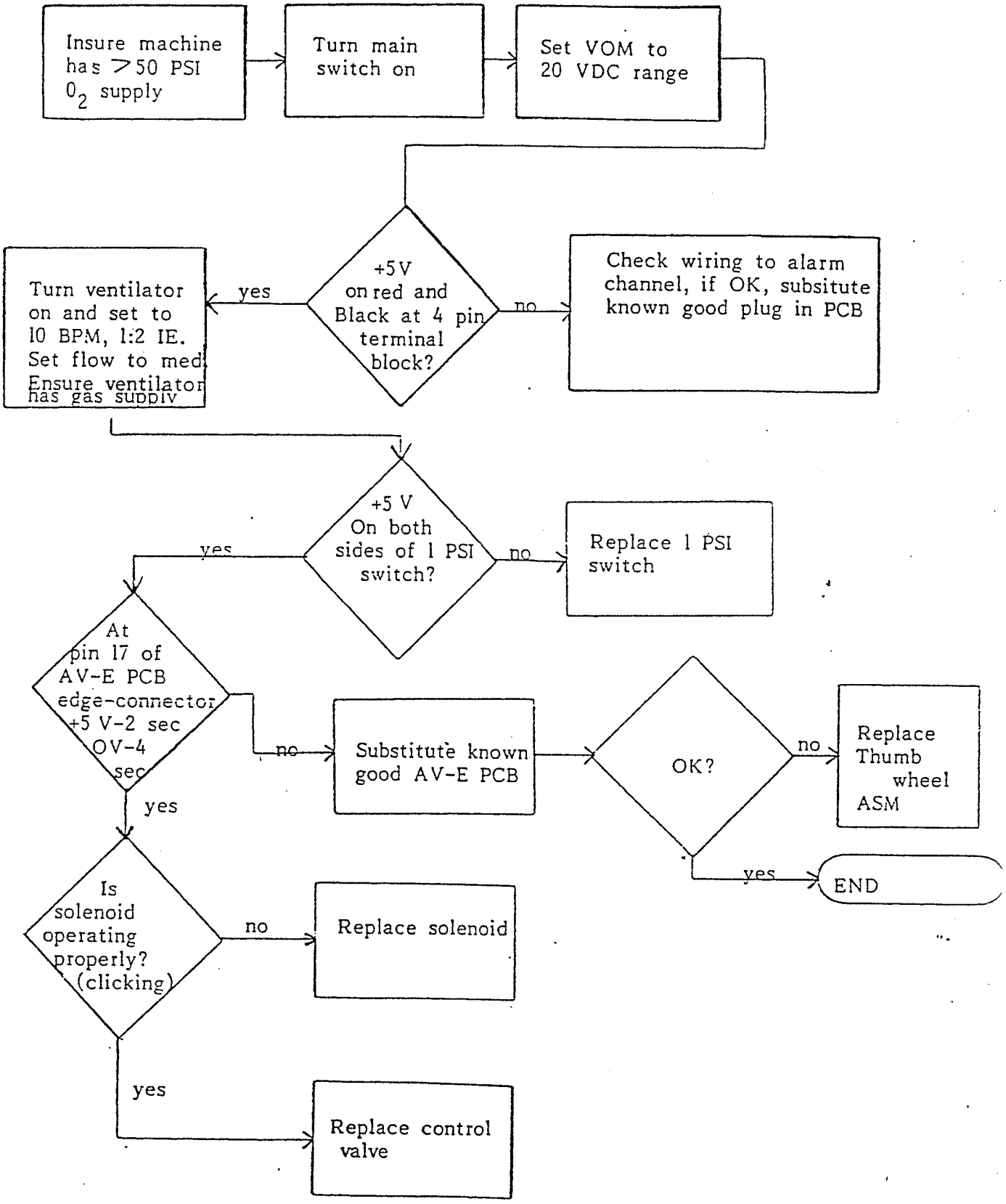
This diagram shows connections before eliminating monitor B from loop



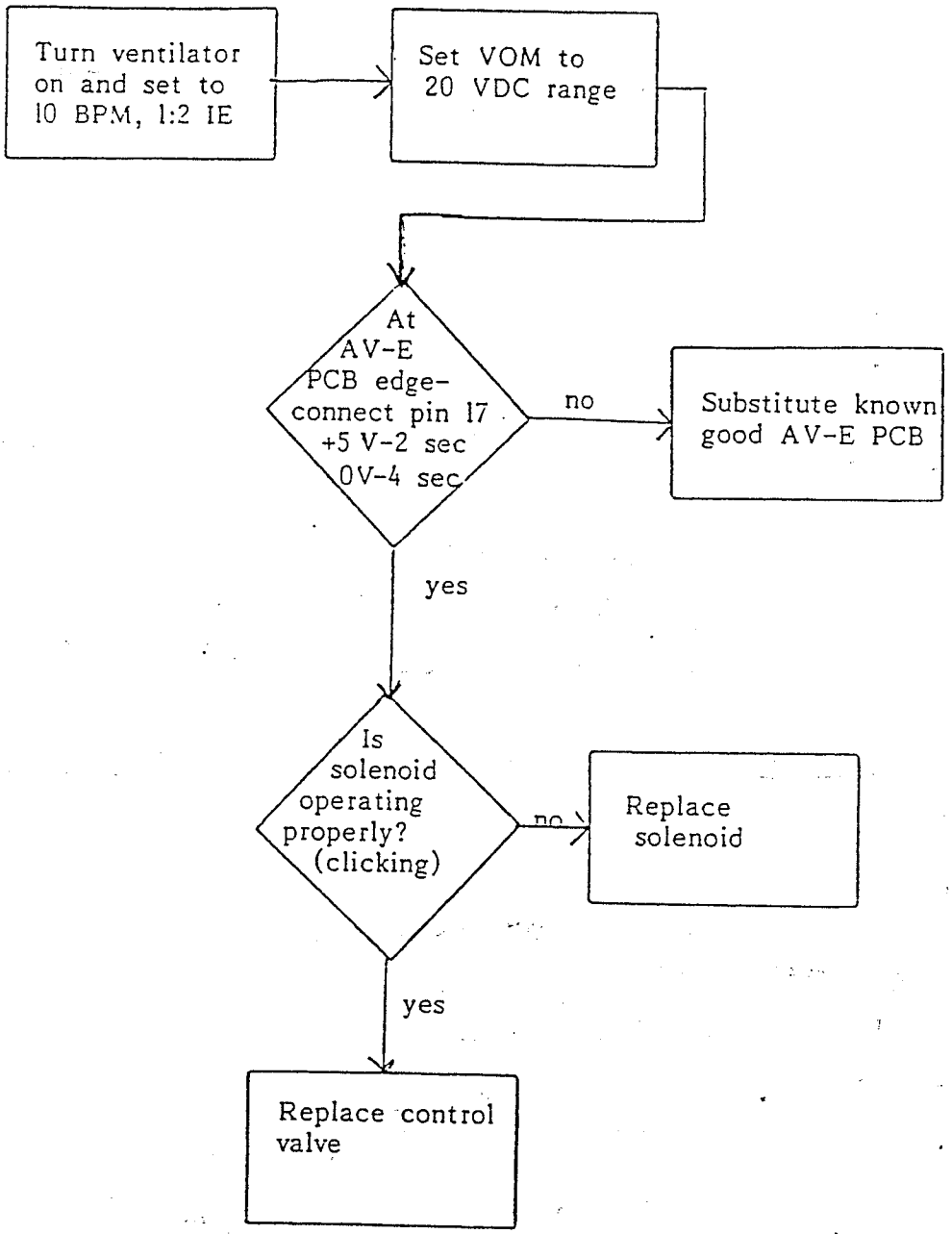
NOTE: Make sure loop is completed when bypassing monitors.

In this diagram, monitor B has been eliminated from data loop. If network down condition disappears, replace monitor that has been eliminated.

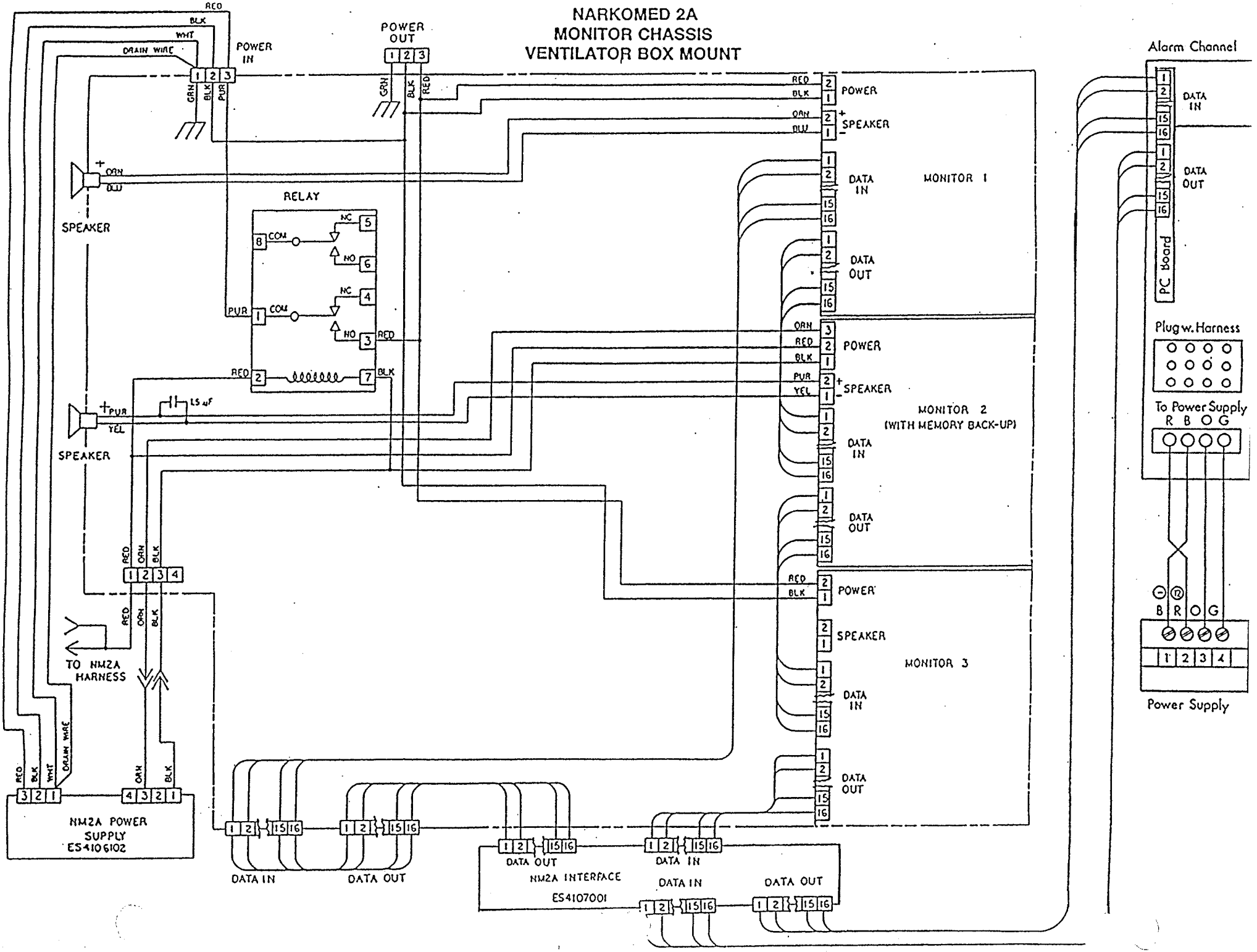
VENTILATOR WILL NOT CYCLE



VENTILATOR STUCK IN INSPIRATORY



NARKOMED 2A
MONITOR CHASSIS
VENTILATOR BOX MOUNT



NORTH AMERICAN DRÄGER EDUCATION DEPARTMENT

NARKOMED 2B

TROUBLESHOOTING GUIDE AND ERROR CODE LOG

TROUBLESHOOTING GUIDE

ANESTHESIA MACHINE TROUBLESHOOTING GUIDE

PROBLEM	POSSIBLE CAUSE	REMEDY
Excessive PEEP	Improperly adjusted vent relief valve	Contact NAD service
	Insufficient suction scavenger flow	Increase suction scavenger flow valve setting
	PEEP valve active	Decrease PEEP valve setting
Excessive NEEP	Excessive suction scavenger flow	Reduce suction scavenger flowrate
Bellows won't reach STOP during expiration	Frequency too high for selected tidal volume	Decrease frequency
		Increase expiratory phase time
	Improperly adjusted vent relief valve	Contact NAD service
Ventilator won't cycle	Frequency set to 00	Select correct frequency
	Low O2 supply pressure	Provide sufficient oxygen supply pressure
Bellows won't compress during inspiration	Absorber manual automatic selector valve in bag position	Place manual/ automatic selector valve in "AUTO" position
	Inspiratory flow control setting on ventilator too low	Increase inspiratory flow control setting
	Frequency too high	Decrease frequency

RESPIRATORY VOLUME MONITOR TROUBLESHOOTING GUIDE

PROBLEM	POSSIBLE CAUSE	REMEDY
Blank display area.	1 full minute has not elapsed (for Minute Volume and Respiratory Rate) since respiration began.	Wait 1 full minute to read display.
	Apnea condition.	Correct apnea condition.
Blank display area & "VOL, SEN DISC" & "VOL ALRM OFF" alarm messages on central alarm display.	Sensor cord disconnected.	Reconnect sensor cord plug to interface panel on anesthesia machine.
	Sensor cord damaged.	Repair sensor cord.
"REVERSE FLOW" alarm message on central alarm display.	Leak between sensor and expiratory valve.	Check for presence of gasket. Make sure that gasket is in good condition and is seated properly.
	Expiratory valve not closing completely during inspiration.	Check expiratory valve disk and pins. Clean, repair, or replace expiratory valve.
	Defective sensor.	Repair or replace sensor.
Tidal Volume readings obtained are consistently low and sensor is noisy during operation.	Excessive friction in sensor.	Lubricate, repair, or replace sensor.

OXYGEN ANALYZER TROUBLESHOOTING GUIDE

PROBLEM	POSSIBLE CAUSE	REMEDY
Display area blank when a reading is expected. "O2 NOT CAL" & "O2 ALRM OFF" messages on central alarm display	Calibration is necessary.	Perform proper calibration. Remove sensor from breathing circuit and press "O2 CAL" key. Make sure sensor is exposed only to room air.
O2 analyzer fails to "remember" calibration	Back-up memory power not available.	Allow anesthesia machine backup battery to recharge.
	Hardware malfunction	Contact NAD Service.
Pressing "O2 CAL" key does not initiate calibration.	Sensor cord is disconnected.	Reconnect sensor cord to input receptacle on anesthesia machine.
	Sensor cord is damaged.	Replace housing/ cord assembly.
Pressing "O2 CAL" key initiates calibration, but display window remains blank at end of calibration period.	Sensor is exposed to incorrect oxygen concentration.	Expose sensor to room air for 21% calibration.
	Sensor exposed to constantly changing calibration mixture.	
	Sensor capsule had been removed from housing for a prolonged period.	Allow for waiting period equal to duration of capsule removal.
	New capsule not given proper waiting period.	Allow for 15 minute waiting period
	Exhausted or defective sensor capsule.	Replace sensor capsule. Allow for 15 minute waiting period.

OXYGEN ANALYZER TROUBLESHOOTING GUIDE (Contd.)

PROBLEM	POSSIBLE CAUSE	REMEDY
During monitoring: "O2 SENS DISC", "O2 ALRM OFF", & "O2 NOT CAL" messages on central alarm display	Defective sensor housing and cable.	Replace housing/ cable assembly.
	Sensor cord is disconnected.	Reconnect sensor cord to input receptacle on anesthesia machine.

BREATHING PRESSURE MONITOR TROUBLESHOOTING GUIDE

PROBLEM	POSSIBLE CAUSE	REMEDY
No pressure readout in display area during ventilation.	Pilot line not connected.	Ensure that pilot line is properly connected.
	Pilot line occluded or kinked.	Ensure that lumen of pilot line is free of obstructions.
Erratic readings.	Condensate accumulation in pilot line.	Drain and reconnect pilot line.

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Technical Service Bulletin #8

DATE: November 9, 1987

TO: Technical Service Representatives

FROM: Timothy C. Horsfield

RE: Narkomed 2B Error Log

The Narkomed 2B store an error log in its backup memory that reflects the results of the various power-up self tests. The contents of this error log can be displayed by entering the access-restricted service menus. The error log indicates any test that has failed since the last time the machine was serviced; thus, the error log may be indicating a failed test even though the machine is currently functional. The log can be cleared by pressing the "RESET" option while the error log is being displayed.
The error log is displayed in the following format:

ERROR LOG 00 1A 00

There are three (3) separate two (2) digit numbers:

	Number 1	Number 2	Number 3
ERROR LOG	00	1A	00

These numbers are in hexadecimal, and when converted to binary indicate directly which test(s) failed (a failed test is indicated by a bit being set, 1 = set).

For example the ERROR LOG 00 1A 00, would look like this when converted to binary:

	Number 1								Number 2								Number 3							
	00								1A								00							
Binary	0	0	0	0	0	0	0	0	0	0	0	1	1	0	1	0	0	0	0	0	0	0	0	0
Test	7	6	5	4	3	2	1	0	7	6	5	4	3	2	1	0	7	6	5	4	3	2	1	0

The following charts should help you to convert from hexadecimal to binary, and determine which test(s) have failed.

HEXADECIMAL TO BINARY

0 = 0 0 0 0	8 = 1 0 0 0
1 = 0 0 0 1	9 = 1 0 0 1
2 = 0 0 1 0	A = 1 0 1 0
3 = 0 0 1 1	B = 1 0 1 1
4 = 0 1 0 0	C = 1 1 0 0
5 = 0 1 0 1	D = 1 1 0 1
6 = 0 1 1 0	E = 1 1 1 0
7 = 0 1 1 1	F = 1 1 1 1

ERROR CODE LISTING

Number 1

LSB
Test 0 - CRT controller fail (readback test)
Test 1 - CRT memory fail (checkerboard test)
Test 2 - CRT memory fail (ROM compare test)
Test 3 - ROM fail (firmware CRC test)
Test 4 - System memory fail (checkerboard test)
Test 5 - System memory fail (ROM compare test)
Test 6 - CTC fail (timer function test)
MSB Test 7 - CTC fail (interrupt logic test)

Number 2

LSB
Test 0 - A/D converter fail (analog voltages out of range)
Test 1 - Primary audio fail (speaker test)
Test 2 - Primary audio fail (sound generation test)
Test 3 - Backup audio fail (speaker test)
Test 4 - Backup audio fail (sound generation test)
Test 5 - Serial port B fail (channel A on UART)
Test 6 - Serial port A fail (channel B on UART)
MSB Test 7 - Clock fail (can not read)

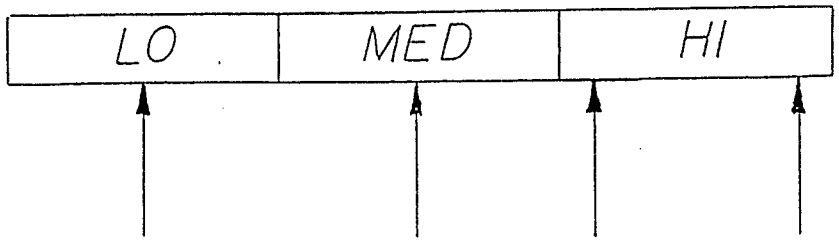
Number 3

LSB
Test 0 - Clock fail (write/readback test)
Test 1 - Clock fail (original time test)
Test 2 - Clock fail (seconds not incrementing)
Test 3 - Backup memory fail (checkerboard test)
Test 4 - Backup memory fail (ROM compare test)
Test 5 - Backup memory fail (array recall test)
Test 6 - AC power fail
MSB Test 7 - Reserve power fail (battery low/disconnect)

In the example ERROR LOG 00 1A 00, the following tests failed:

Primary audio fail (speaker test)
Backup audio fail (speaker test)
Backup audio fail (sound generation test)

NAD AIR INJECTOR



	LO	MED	HI	
OXYGEN FLOW TO AIR INJECTOR (L/MIN) (venturi)	7.5	12.5	16.5	22.5
GAS FLOW TO CANISTER (L/MIN)	46	82	99	118
OXYGEN CONCENTR. IN CANISTER (% O_2)	← APPROX. 33 % → dumped into the room but diluted almost immediately.			

Oxygen Consumption per Hour

Example:

oxygen fresh gas flow	-	2.5 l/min
inspiratory flow rate at medium	-	12.5 l/min
frequency	-	10 BPM
inspiratory/expiratory (I:E) ratio	-	1:2

At the above respiratory rate, each cycle is 6 seconds long. Inspiration will take 2 seconds and expiration 4 seconds. Oxygen will only be consumed by the air entrainer (venturi) during inspiration. Therefore inspiration lasts only 20 seconds during one minute. To consume 12.5 l/min of oxygen, the air entrainer must be activated for 60 seconds or 3 minutes. During these 3 minutes the total fresh gas flow will be 7.5 liters. The entire oxygen consumption is therefore 20 liters in 3 minutes or 400 liters per hour.

An oxygen E-cylinder contains approxemately 625 liters (22 cuft), while an H-cylinder contains 6,905 liters (244 cuft) of oxygen

If 400 liters of oxygen consumption per hour is divided into the volumes of these cylinders, an E-cylinder will last approxemately 1.56 hours or 1 hour, 34 minutes, and an H-cylinder 17. 26 hours or 17 hours, 15 minutes.

NOTE:
The decrease of pressure indicated at the sphygmomanometer gauge during the following 30 (thirty) seconds shall not exceed 10 mm Hg

Attach test sphygmomanometer in series with unit to be tested. Both sphygmomanometers must have identical readings

VAPOR EXCLUSION SYSTEM TEST

Check the vaporizer exclusion device, which prevents more than one vaporizer from being activated simultaneously. Make sure that when each vaporizer handwheel is turned to a setting greater than 0, the others remain locked in their 0 positions. Then, turn all vaporizers to the 0 positions.

HIGH PRESSURE TEST
NOTE:

Test to be performed with each gas independently
Set System Power switch to stand-by
Close flow control valve
Open cylinder valve until indicated pressure at cylinder pressure gauge stabilizers
Close cylinder valve

NOTE:

The decrease of pressure indicated on the pressure gauge during the following 2 (two) minutes shall not exceed 50psi

Test must be repeated for gases with 2 (two) yokes by moving cylinder to second yoke and inserting yoke plug into yoke which has no cylinder

Check cylinder yokes for loose or missing yoke pins

OXYGEN SUPPLY PRESSURE FAILURE PROTECTION DEVICE

Check the oxygen failure protection device: With all gases available on the machine set to a flow of a about 1 L/min, discontinue the oxygen flow by disconnecting the oxygen pipeline supply hose and closing the oxygen reserve cylinder(s). The flow of all other gases, as indicated by their flowmeters, shall decrease in proportion to the decrease in proportion to the decrease in oxygen flow and eventually shut off.

	752parts	880725
1	8085	U1
1	2764	U4
1	2817	U5
1	8155	U6
2	8253	U8,U32
1	8279	U7
2	74LS138	U3,U10
1	74LS373	U2
2	74LS02	U9,U34
1	74LS04	U30
1	74LS32	U31
12	LTS6960HR	U11-U21,U39
1	74LS154	U22
1	74LS240	U23
3	14051B	U24,U25,U37
3	LF356	U26,U35,U38
1	XR4151	U27
1	ADC0844	U28
1	555	U29
1	LM339	U33
1	TL497A	U36
1	1.00 MHZ CRYSTAL	Y1
6	1N4148	D1-D3,D12,D13,D16
2	6A05	D4,D5
2	1N4001	D6,D7
1	1N5242	D9
1	1N5229	D10
1	SD290-11-11-041	D11
1	MR851	D14
1	1N5239	D15
1	1N5341	D17
20	RED LED	DS1-DS20
1	7805	VR1
1	7812	VR2
1	LM350T	VR3
15	MPSU51	Q1-Q13,Q19,Q20
1	TL431CLP	Q14
2	2N3906	Q15,Q21
1	2N3904	Q16
1	MPSA13	Q17
1	TIP32	Q18
1	100UH INDUCTOR,1536T	L1
1	8R,SPEAKER,2"	LS1
1	167M28 TRANSFORMER	T1
1	643 HEATSINK	HS1
1	290B HEATSINK	HS2
1	1A,3AG FUSE	F1

2	KEYSTONE FUSE CLIPS	FC
1	22PF,CER CAP	C1
1	4U7,10V,ELECTRO CAP	C2
2	10UF,25V,TANT CAP	C3,C5
1	0.1UF,TANT CAP	C4
1	2200UF,10V,ELECTRO CAP	C6
24	0.1UF CER CAP	C7,C8,C13,C18,C20,C21,C101-115,C118, C120,C123
1	150PF,CER CAP	C10
1	1UF ELECTRO CAP	C11
8	10UF,25V,ELECTRO CAP	C14,C16,C116,C117,C119,C121,C122,C124
2	10,000UF,25V ELECTRO CAP	C15,C17
1	47UF,25V ELECTRO CAP	C9
1	16 PIN HEADER	J3
3	3 PIN HEADER	J2,J5,J10
5	5 PIN HEADER	J1,J4,J6,J8,J9
1	3 PIN HEADER,.156 18GA	J7
3	3 POS. CONNECTOR	P2,P5,P10
5	5 POS. CONNECTOR	P1,P4,P6,P8,P9
1	3 POS CONNECTOR .156	P7
5	8 PIN SOCKET,SOLDER	U26,U27,U29,U35,U38
12	10 PIN SOCKET,SOLDER	U11-21,U39
	USE 3-40 PIN, 1.5-24 PIN SOCKETS	
6	14 PIN SOCKET,SOLDER	U9,U30,U31,U33,U34,U36
5	16 PIN SOCKET,SOLDER	U3,U10,U24,U25,U37
3	20 PIN SOCKET,SOLDER	U2,U23,U28
4	24 PIN SOCKET,SOLDER	U5,U8,U22,U32
1	28 PIN SOCKET,SOLDER	U4
	LEAVE U40 BLANK	
3	40 PIN SOCKET,SOLDER	U1,U6,U7
1	100K POT	R48
1	1K POT	R50
2	500R POT	R79,R102
1	100R POT	R110
1	75K	R1
3	2K	R2,R54,R76
15	330R	R4,R6,R8,R10,R12,R14,R16,R18,R20,R22, R24,R26,R28,R103,R104
17	2K2	R3,R5,R7,R9,R11,R13,R15,R17,R19,R21, R23,R25,R27,R105,R106,R75,R77
8	56R	R29-R36
11	10K	R63,R67,R70,R72,R80-R82,R95,R97,R98,R109
7	27K	R38-R44
1	270R	R65
1	18K	R71
2	200K	R66,Off-board
2	47K	R37,R96
3	1M	R45,R46,R74
1	560K	R49

1	390K	R47
2	1K8	R101,R59
4	1K	R69,R89,R90,R108
2	6K8	R52,R62
2	100K	R51,R78
1	430R	R56
1	4K3	R57
1	2K7	R60
1	4K7	R61
1	20R	R64
1	15K	R53
2	1K5	R68,R58
1 ✓	560R	~~R67~~,R84
1	68K	R55
3	22M	Off-board
1	5K6	R94
1	3K0	R91
1	5K1	R92
1	2K4	R93
1	15R,5W	R83
1	47R	R85
1	330R,0.5W	R86
1	3K9	R87
1	1K2	R88
1	240R	R100
1	~~390R~~ 22R, 0.5W	R99

NORTH AMERICAN DRÄGER EDUCATION DEPARTMENT

NARKOMED 2B

TROUBLESHOOTING GUIDE AND ERROR CODE LOG

TROUBLESHOOTING GUIDE

ANESTHESIA MACHINE TROUBLESHOOTING GUIDE

PROBLEM	POSSIBLE CAUSE	REMEDY
Excessive PEEP	Improperly adjusted vent relief valve	Contact NAD service
	Insufficient suction scavenger flow	Increase suction scavenger flow valve setting
	PEEP valve active	Decrease PEEP valve setting
Excessive NEEP	Excessive suction scavenger flow	Reduce suction scavenger flowrate
Bellows won't reach STOP during expiration	Frequency too high for selected tidal volume	Decrease frequency
		Increase expiratory phase time
	Improperly adjusted vent relief valve	Contact NAD service
Ventilator won't cycle	Frequency set to 00	Select correct frequency
	Low O2 supply pressure	Provide sufficient oxygen supply pressure
Bellows won't compress during inspiration	Absorber manual automatic selector valve in bag position	Place manual/ automatic selector valve in "AUTO" position
	Inspiratory flow control setting on ventilator too low	Increase inspiratory flow control setting
	Frequency too high	Decrease frequency

RESPIRATORY VOLUME MONITOR TROUBLESHOOTING GUIDE

PROBLEM	POSSIBLE CAUSE	REMEDY
Blank display area.	1 full minute has not elapsed (for Minute Volume and Respiratory Rate) since respiration began.	Wait 1 full minute to read display.
	Apnea condition.	Correct apnea condition.
Blank display area & "VOL, SEN DISC" & "VOL ALRM OFF" alarm messages on central alarm display.	Sensor cord disconnected.	Reconnect sensor cord plug to interface panel on anesthesia machine.
	Sensor cord damaged.	Repair sensor cord.
"REVERSE FLOW" alarm message on central alarm display.	Leak between sensor and expiratory valve.	Check for presence of gasket. Make sure that gasket is in good condition and is seated properly.
	Expiratory valve not closing completely during inspiration.	Check expiratory valve disk and pins. Clean, repair, or replace expiratory valve.
	Defective sensor.	Repair or replace sensor.
Tidal Volume readings obtained are consistently low and sensor is noisy during operation.	Excessive friction in sensor.	Lubricate, repair, or replace sensor.

OXYGEN ANALYZER TROUBLESHOOTING GUIDE

PROBLEM	POSSIBLE CAUSE	REMEDY
Display area blank when a reading is expected. "O2 NOT CAL" & "O2 ALRM OFF" messages on central alarm display	Calibration is necessary.	Perform proper calibration. Remove sensor from breathing circuit and press "O2 CAL" key. Make sure sensor is exposed only to room air.
O2 analyzer fails to "remember" calibration	Back-up memory power not available.	Allow anesthesia machine backup battery to recharge.
	Hardware malfunction	Contact NAD Service.
Pressing "O2 CAL" key does not initiate calibration.	Sensor cord is disconnected.	Reconnect sensor cord to input receptacle on anesthesia machine.
	Sensor cord is damaged.	Replace housing/ cord assembly.
Pressing "O2 CAL" key initiates calibration, but display window remains blank at end of calibration period.	Sensor is exposed to incorrect oxygen concentration.	Expose sensor to room air for 21% calibration.
	Sensor exposed to constantly changing calibration mixture.	
	Sensor capsule had been removed from housing for a prolonged period.	Allow for waiting period equal to duration of capsule removal.
	New capsule not given proper waiting period.	Allow for 15 minute waiting period
	Exhausted or defective sensor capsule.	Replace sensor capsule. Allow for 15 minute waiting period.

OXYGEN ANALYZER TROUBLESHOOTING GUIDE (Contd.)

PROBLEM	POSSIBLE CAUSE	REMEDY
During monitoring: "O2 SENS DISC", "O2 ALRM OFF", & "O2 NOT CAL" messages on central alarm display	Defective sensor housing and cable.	Replace housing/ cable assembly.
	Sensor cord is disconnected.	Reconnect sensor cord to input receptacle on anesthesia machine.

BREATHING PRESSURE MONITOR TROUBLESHOOTING GUIDE

PROBLEM	POSSIBLE CAUSE	REMEDY
No pressure readout in display area during ventilation.	Pilot line not connected.	Ensure that pilot line is properly connected.
	Pilot line occluded or kinked.	Ensure that lumen of pilot line is free of obstructions.
Erratic readings.	Condensate accumulation in pilot line.	Drain and reconnect pilot line.

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NOAMDRAGER TEL

Technical Service Bulletin #8

DATE: November 9, 1987

TO: Technical Service Representatives

FROM: Timothy C. Horsfield

RE: Narkomed 2B Error Log

The Narkomed 2B store an error log in its backup memory that reflects the results of the various power-up self tests. The contents of this error log can be displayed by entering the access-restricted service menus. The error log indicates any test that has failed since the last time the machine was serviced; thus, the error log may be indicating a failed test even though the machine is currently functional. The log can be cleared by pressing the "RESET" option while the error log is being displayed.
The error log is displayed in the following format:

ERROR LOG 00 1A 00

There are three (3) separate two (2) digit numbers:

	Number 1	Number 2	Number 3
ERROR LOG	00	1A	00

These numbers are in hexadecimal, and when converted to binary indicate directly which test(s) failed (a failed test is indicated by a bit being set, 1 = set).

For example the ERROR LOG 00 1A 00, would look like this when converted to binary:

	Number 1								Number 2								Number 3							
	00								1A								00							
Binary	0	0	0	0	0	0	0	0	0	0	0	1	1	0	1	0	0	0	0	0	0	0	0	0
Test	7	6	5	4	3	2	1	0	7	6	5	4	3	2	1	0	7	6	5	4	3	2	1	0

The following charts should help you to convert from hexadecimal to binary, and determine which test(s) have failed.

HEXADECIMAL TO BINARY

0 = 0 0 0 0	8 = 1 0 0 0
1 = 0 0 0 1	9 = 1 0 0 1
2 = 0 0 1 0	A = 1 0 1 0
3 = 0 0 1 1	B = 1 0 1 1
4 = 0 1 0 0	C = 1 1 0 0
5 = 0 1 0 1	D = 1 1 0 1
6 = 0 1 1 0	E = 1 1 1 0
7 = 0 1 1 1	F = 1 1 1 1

ERROR CODE LISTING

Number 1

Test 0 - CRT controller fail (readback test)
Test 1 - CRT memory fail (checkerboard test)
Test 2 - CRT memory fail (ROM compare test)
Test 3 - ROM fail (firmware CRC test)
Test 4 - System memory fail (checkerboard test)
Test 5 - System memory fail (ROM compare test)
Test 6 - CTC fail (timer function test)
Test 7 - CTC fail (interrupt logic test)

Number 2

Test 0 - A/D converter fail (analog voltages out of range)
Test 1 - Primary audio fail (speaker test)
Test 2 - Primary audio fail (sound generation test)
Test 3 - Backup audio fail (speaker test)
Test 4 - Backup audio fail (sound generation test)
Test 5 - Serial port B fail (channel A on UART)
Test 6 - Serial port A fail (channel B on UART)
Test 7 - Clock fail (can not read)

Number 3

Test 0 - Clock fail (write/readback test)
Test 1 - Clock fail (original time test)
Test 2 - Clock fail (seconds not incrementing)
Test 3 - Backup memory fail (checkerboard test)
Test 4 - Backup memory fail (ROM compare test)
Test 5 - Backup memory fail (array recall test)
Test 6 - AC power fail
Test 7 - Reserve power fail (battery low/disconnect)

In the example ERROR LOG 00 1A 00, the following tests failed:

Primary audio fail (speaker test)
Backup audio fail (speaker test)
Backup audio fail (sound generation test)

Turn handwheel to maximum concentration setting

Turn oxygen flow to 10 L/min for at least 20 (twenty) minutes

NOTE:

This procedure must be performed in a well ventilated area without personnel present

Turn handwheel to 0 (zero) and replace filler and drain plugs

Turn oxygen flow OFF

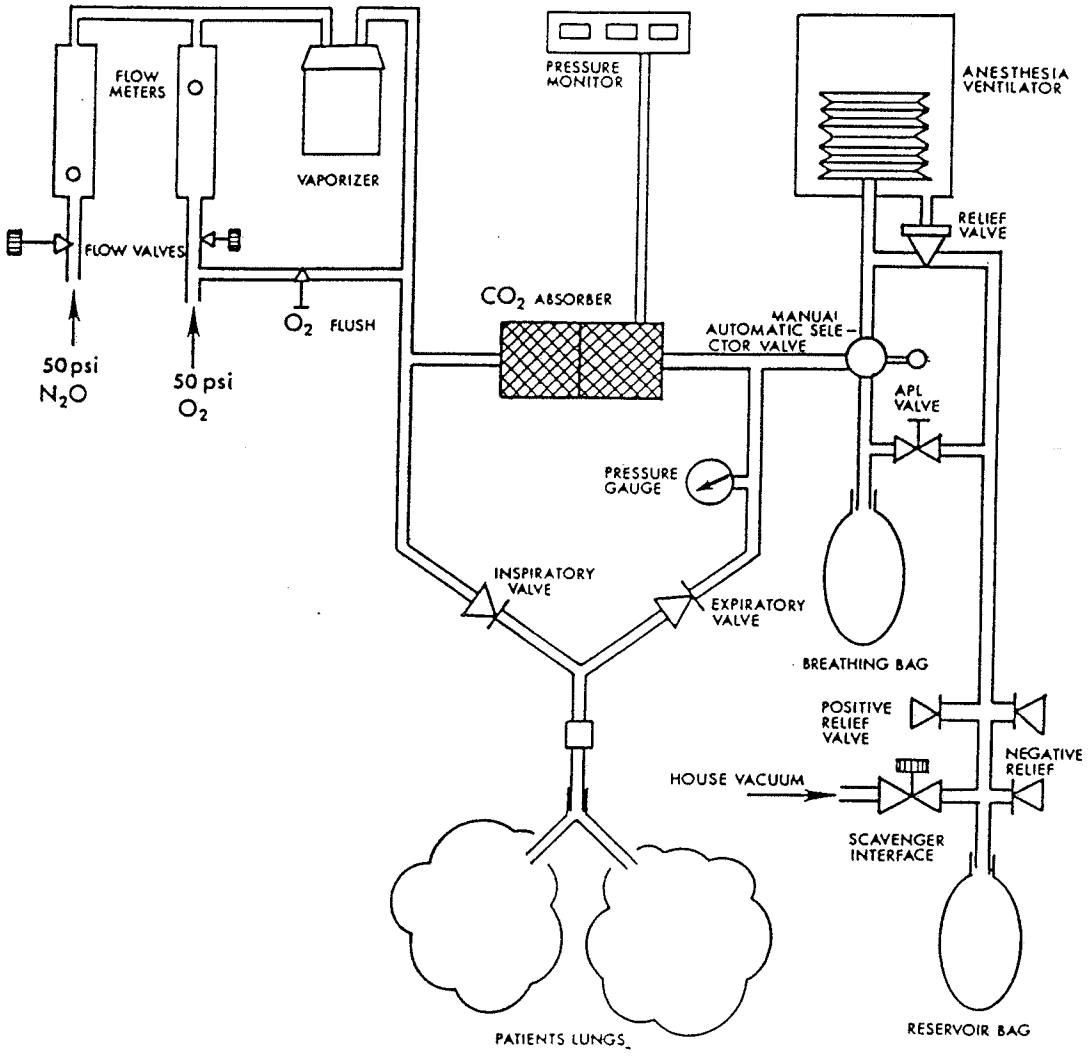
Remove Vapor vaporizer from mount

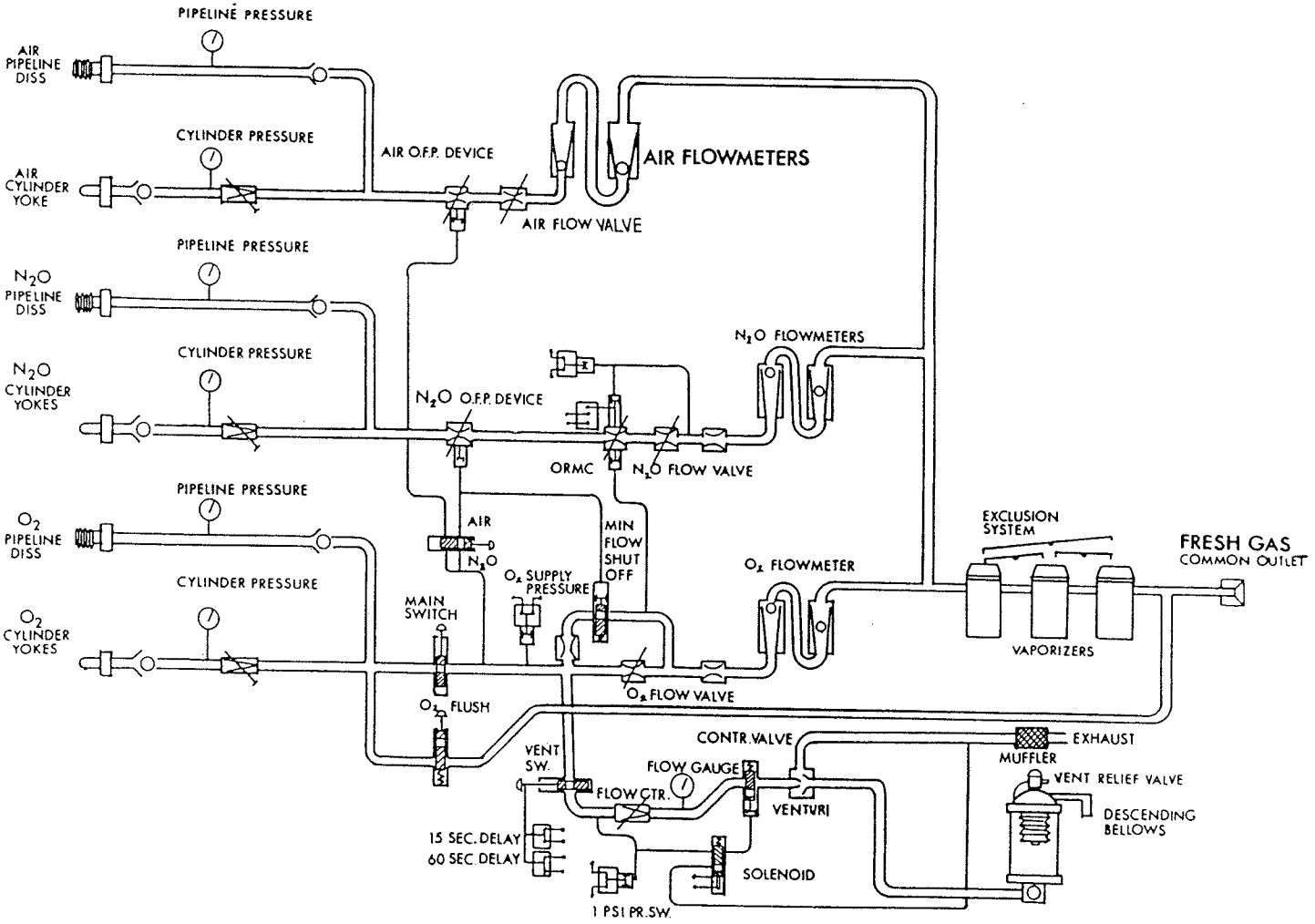
Package vaporizer very carefully for shipment

Tab 4

SCHEMATICS AND DIAGRAMS

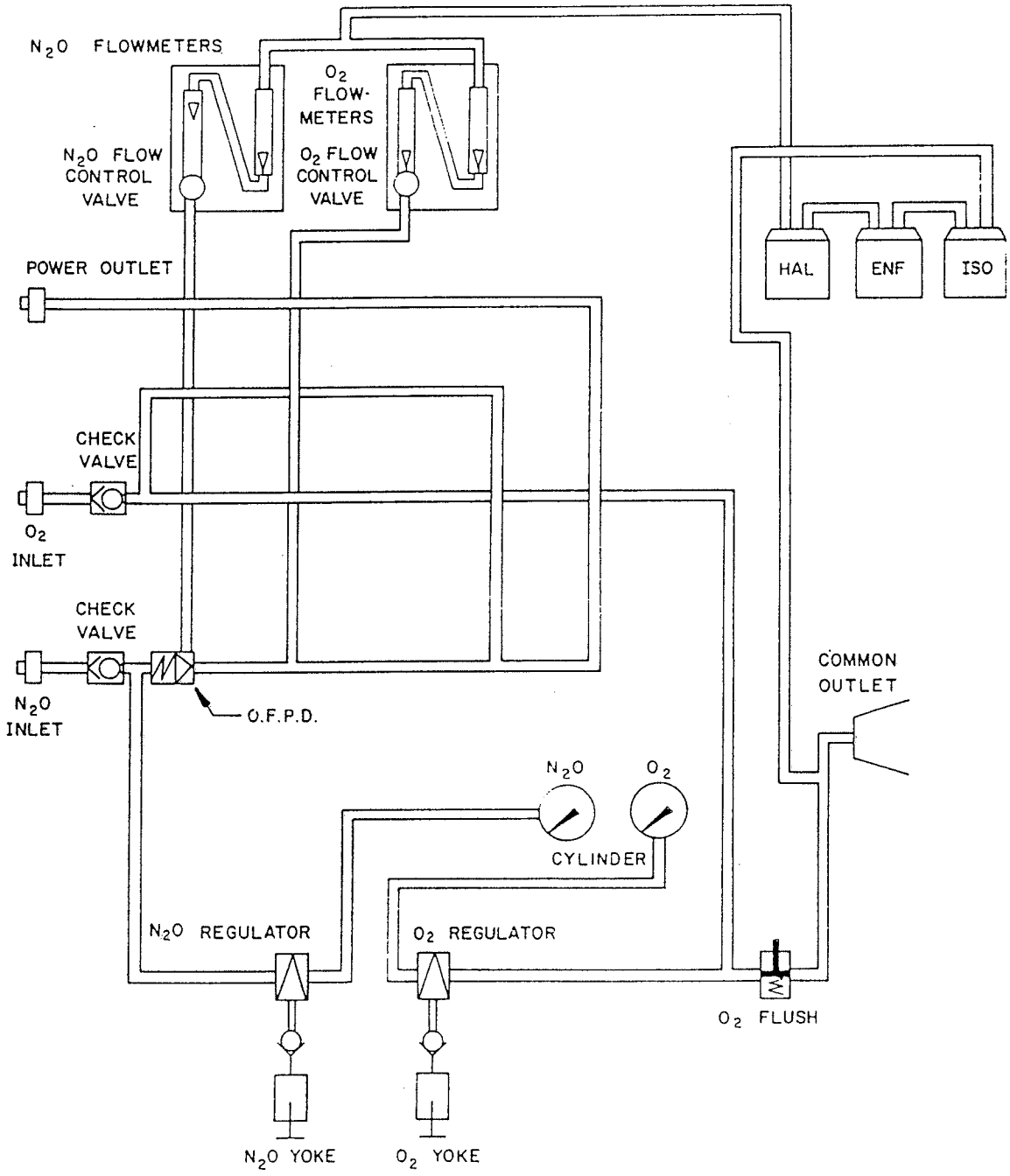
ANESTHESIA SYSTEM
WITH PATIENT BREATHING CIRCUIT



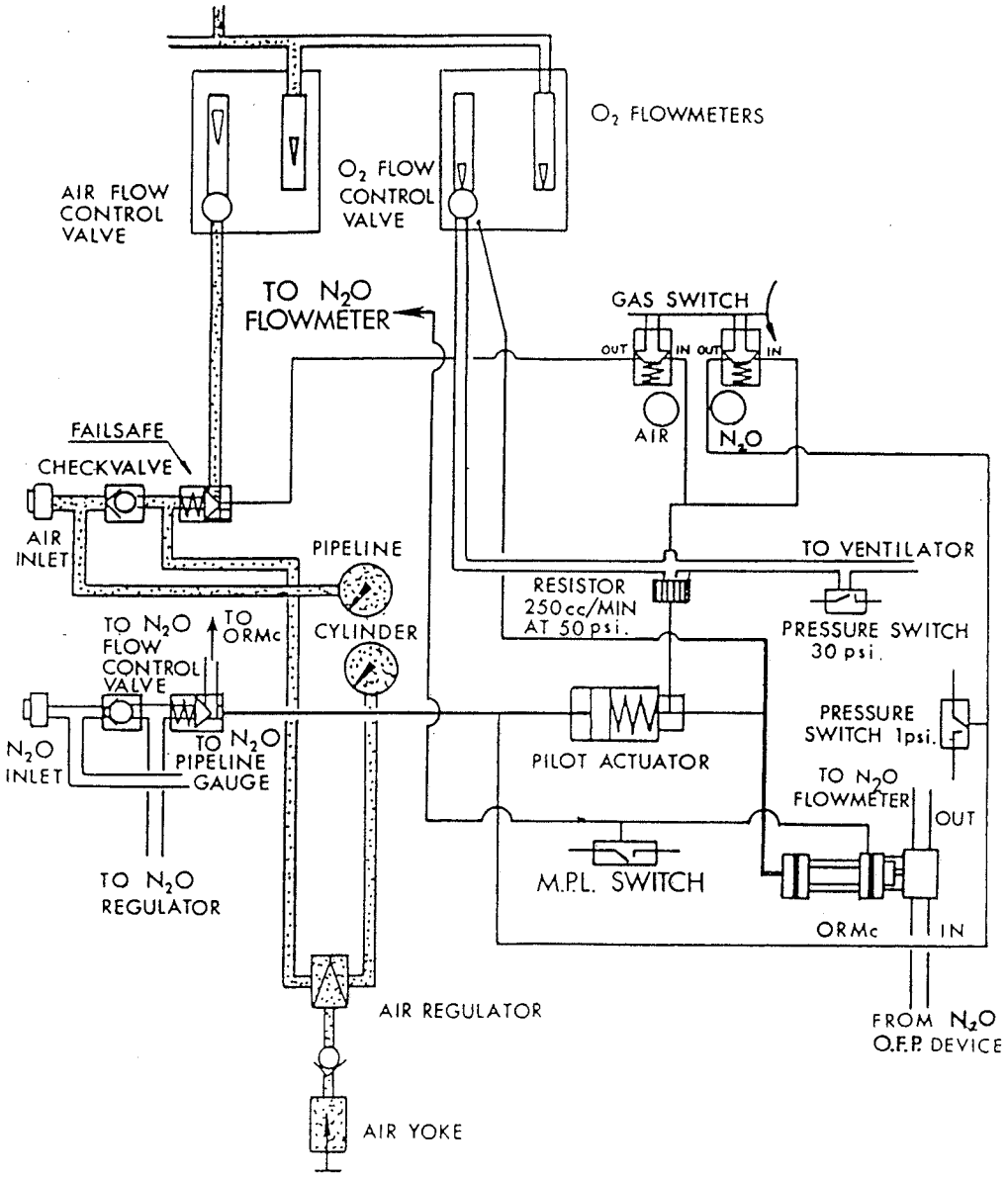


PIPING DIAGRAM
NARKOMED 2A

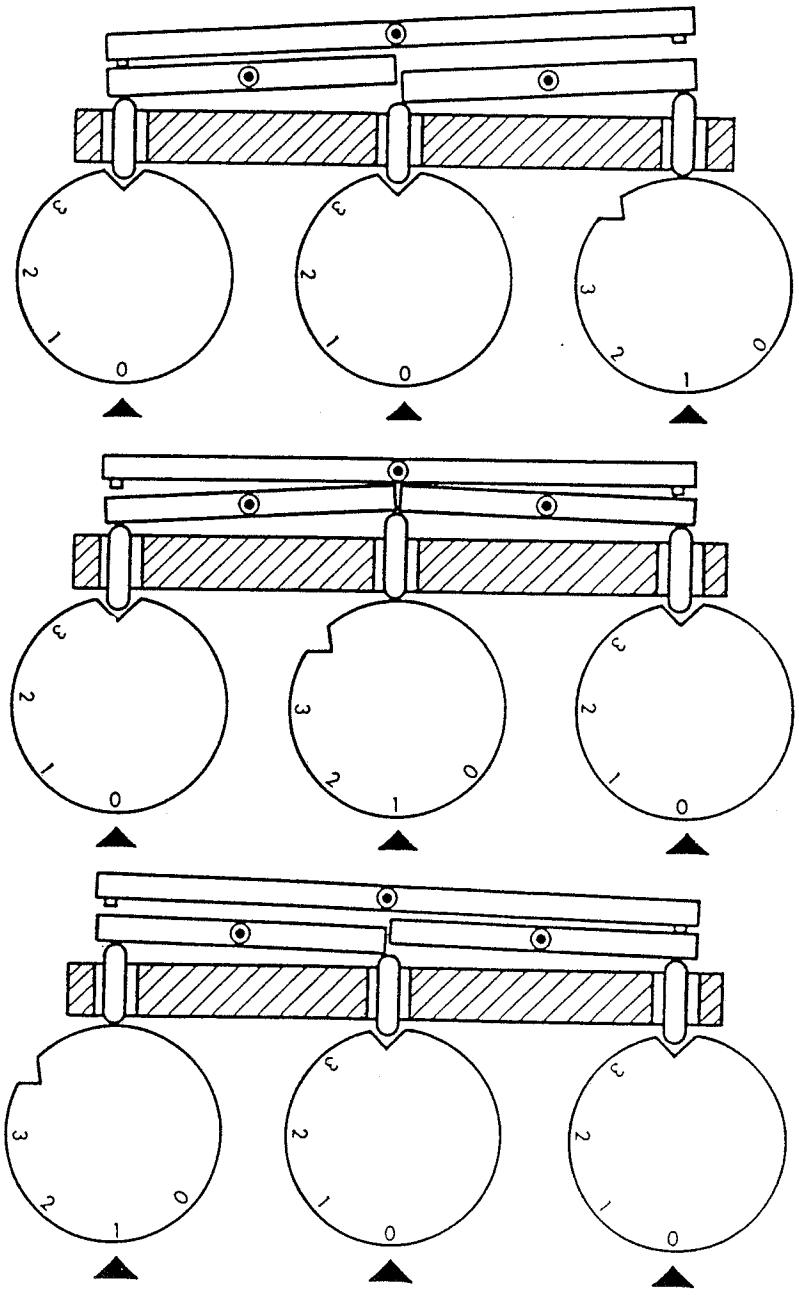
NARKOMED STANDARD
2 Gas, 2 Yoke



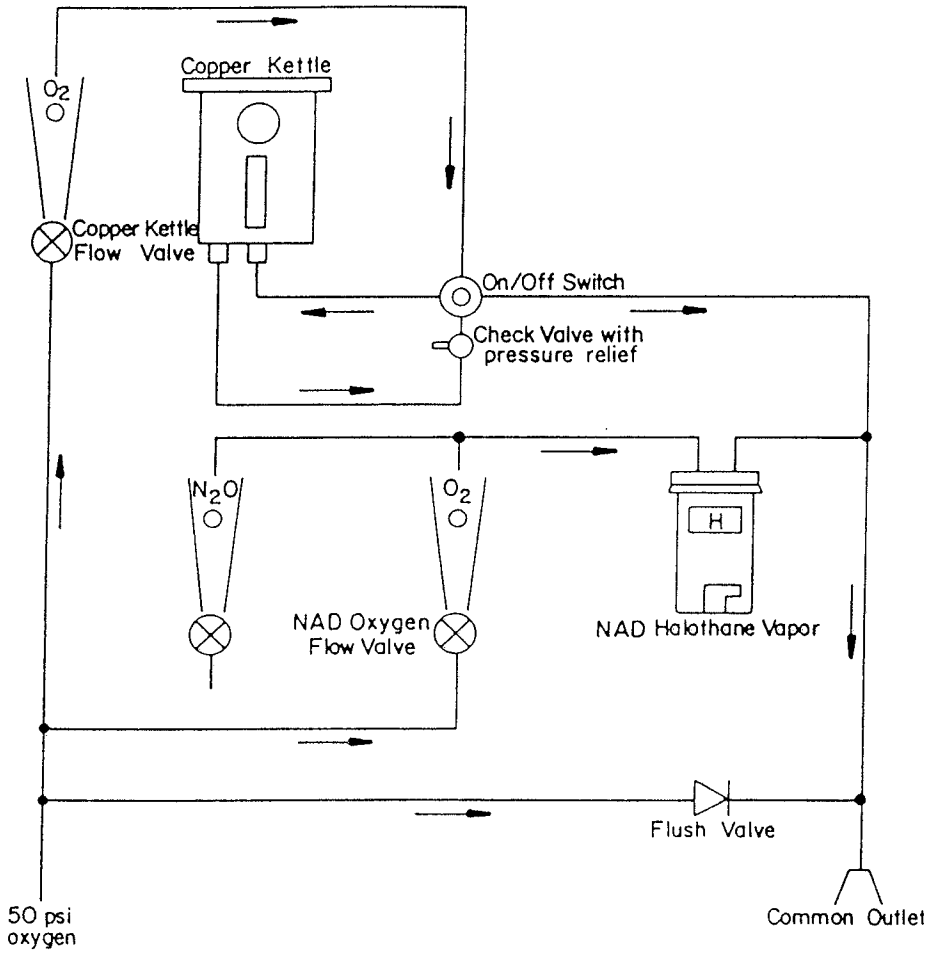
AIR ATTACHMENT, DISS/YOKE

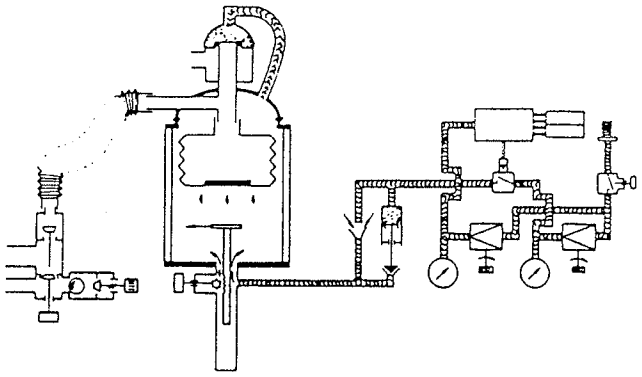


3 VAPOR EXCLUSION SYSTEM



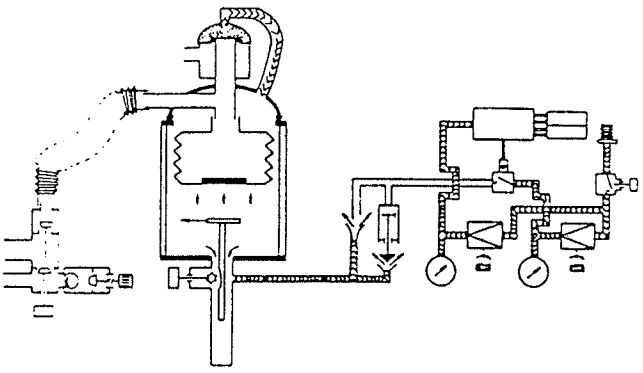
PIPING DIAGRAM FOR NARKOMED STANDARED (Copper Kettle)

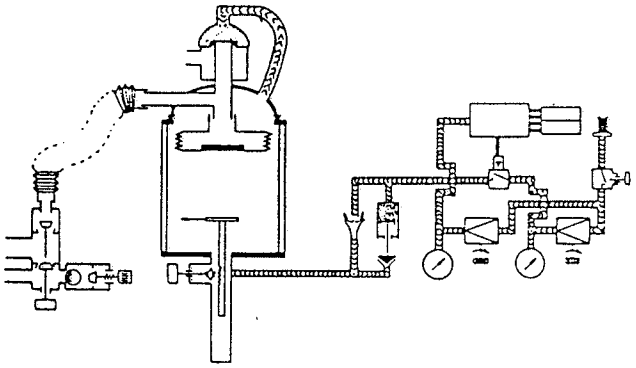




INSPIRATORY FLOW TIME

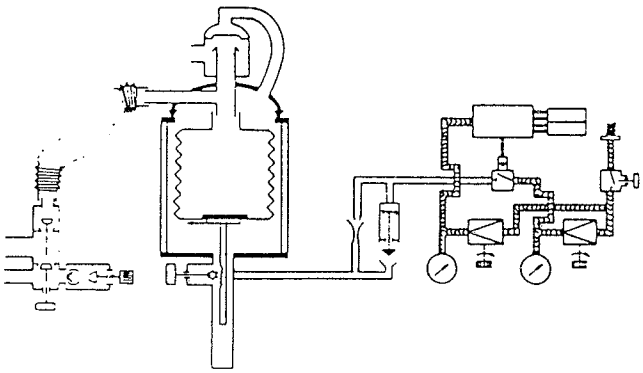
EXPIRATORY FLOW TIME



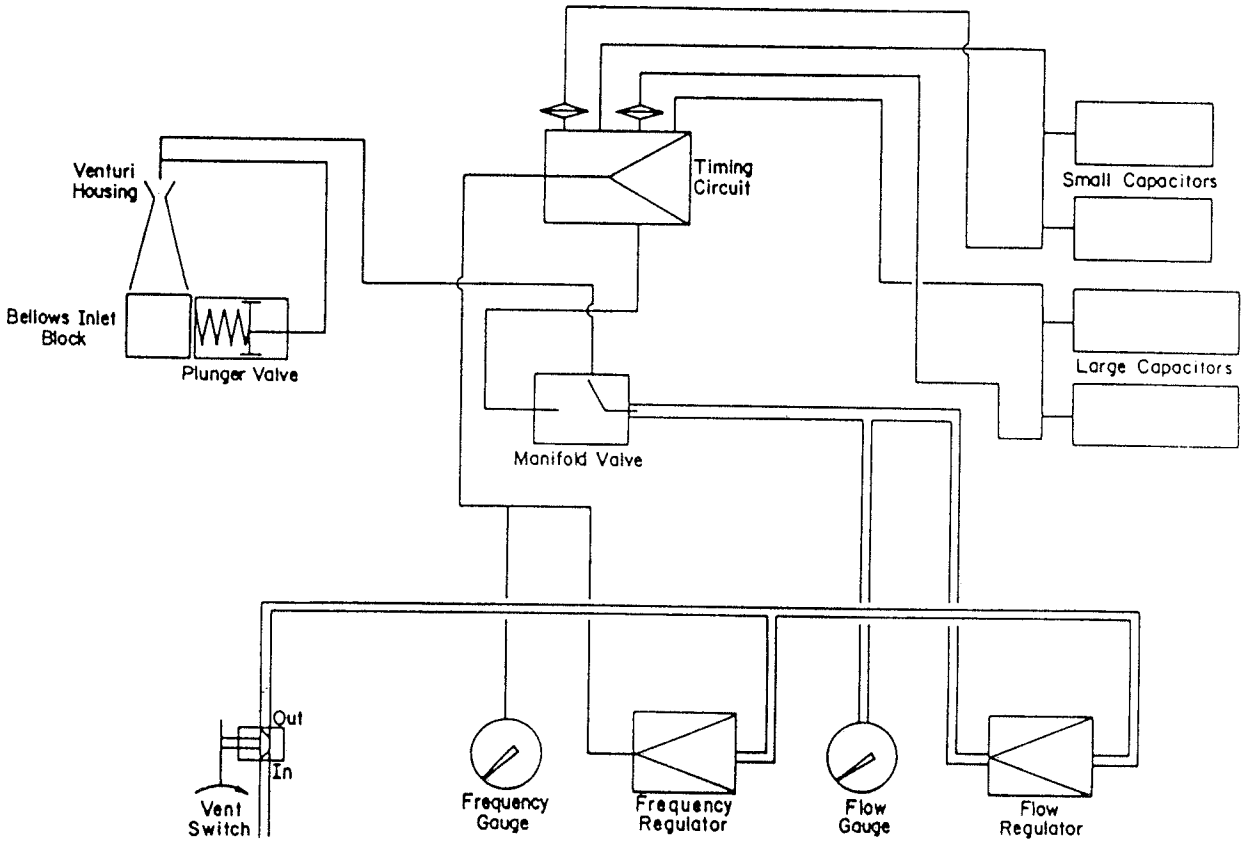


INSPIRATORY PAUSE TIME

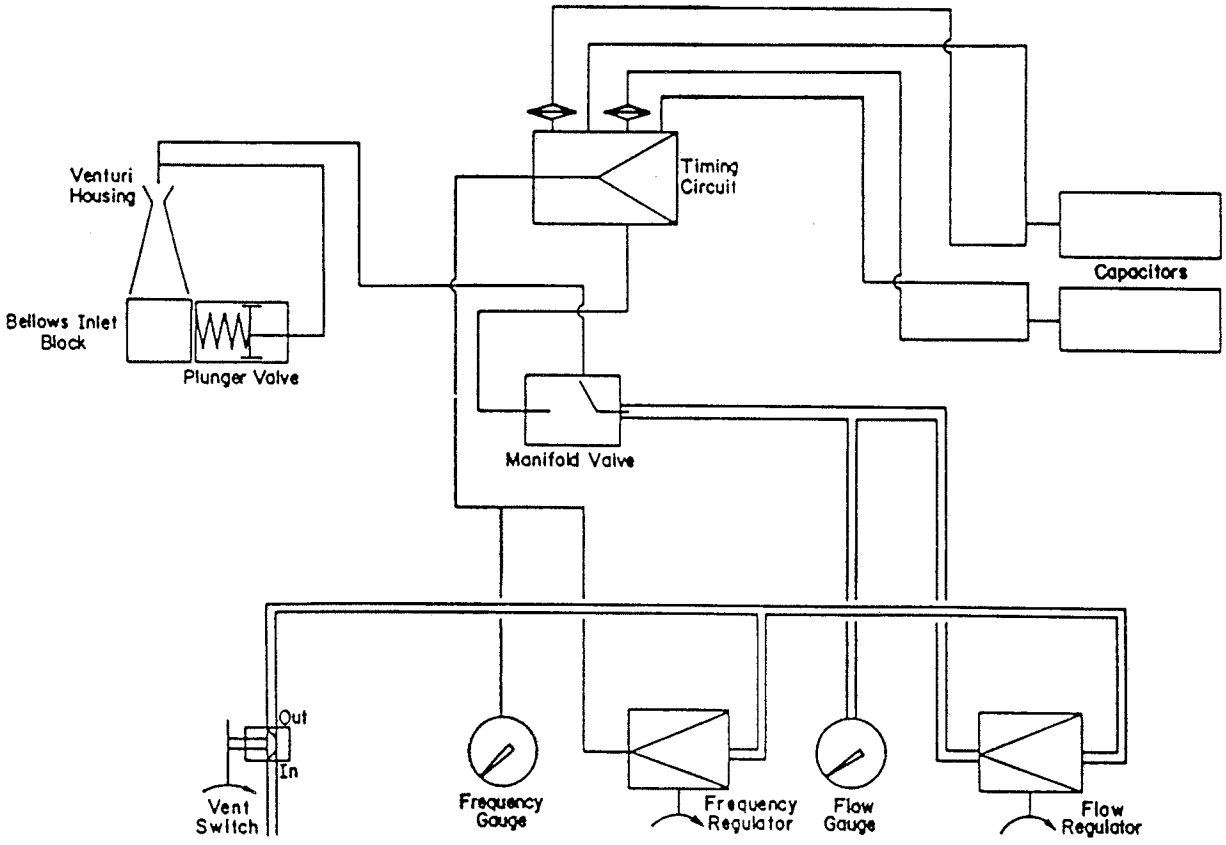
EXPIRATORY PAUSE TIME



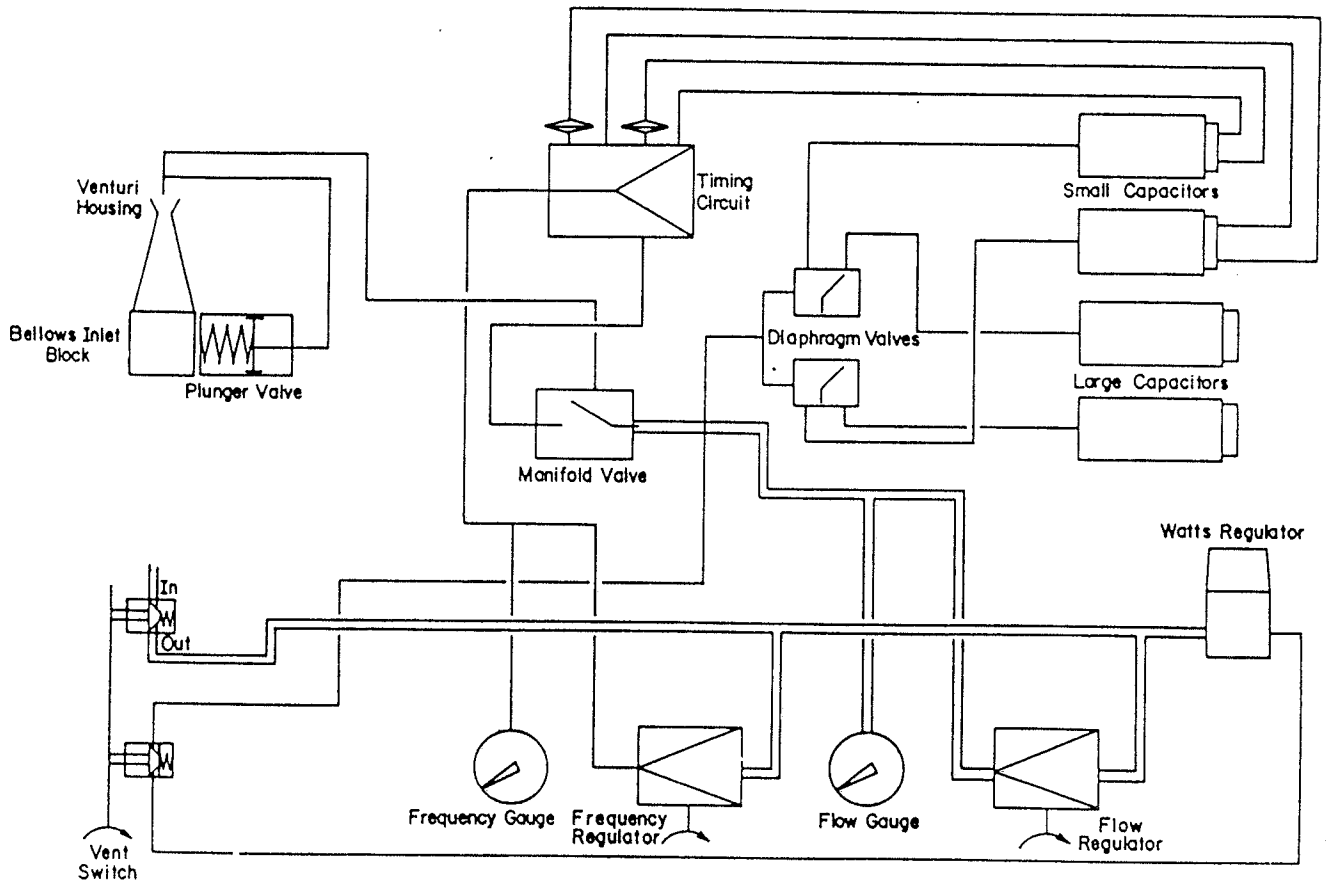
DRAGER AV 16 - 18 BPM



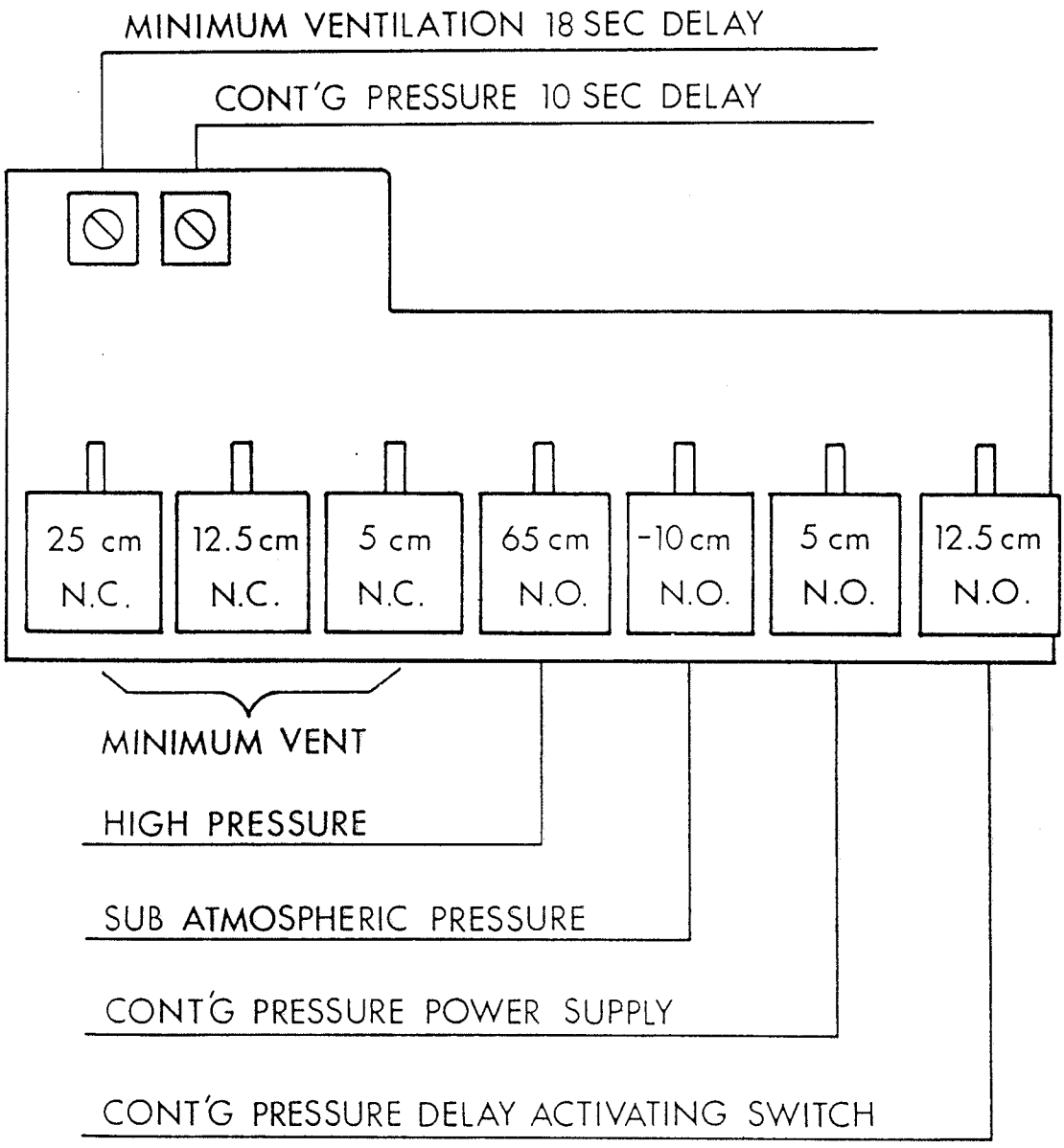
DRAGER AV 10 - 30 BPM
9 - 25 BPM



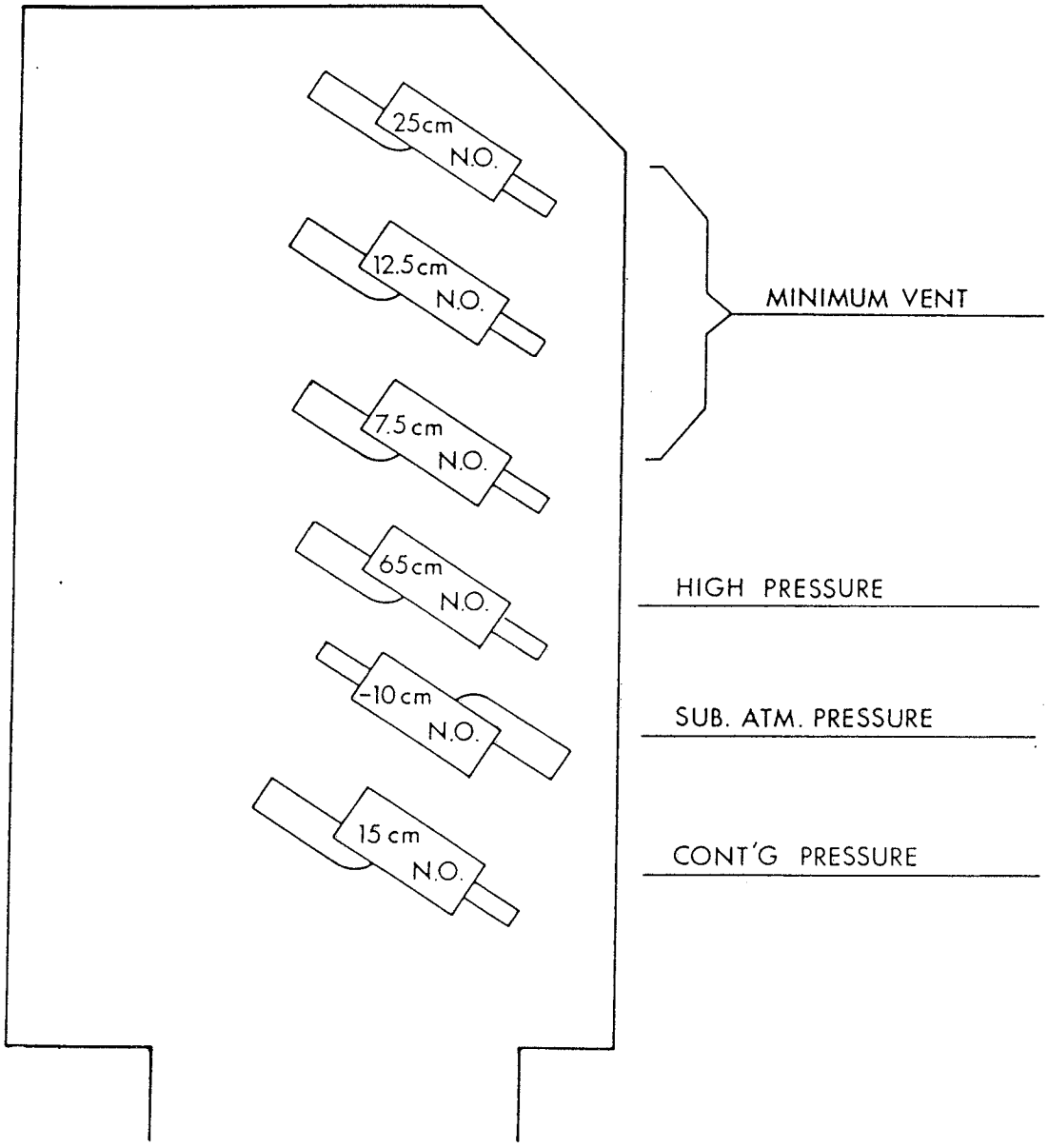
DRAGER AV / FREQUENCY DIVIDER



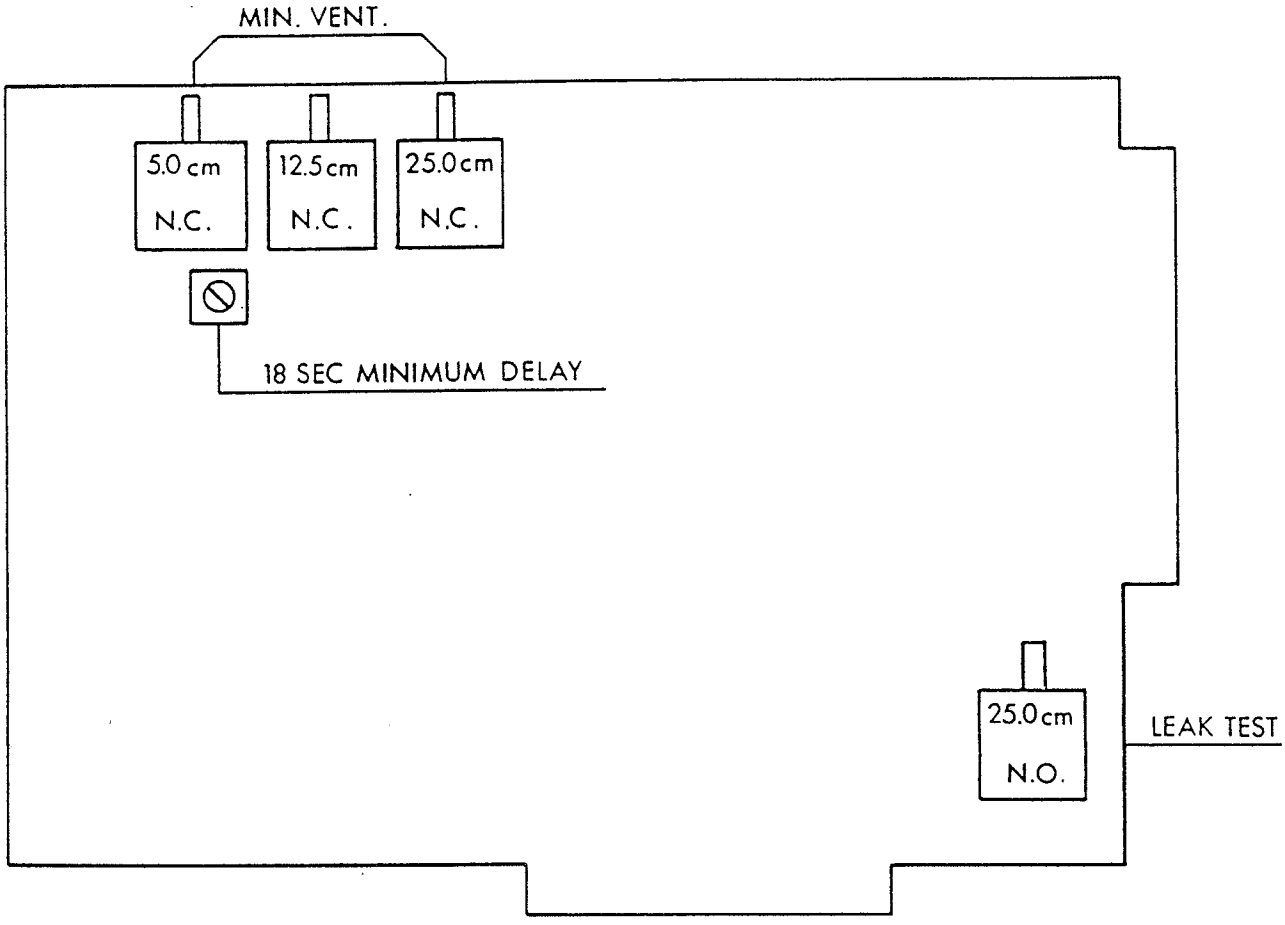
DPM II


MINIMUM VENTILATION 18 SEC DELAY
CONT'G PRESSURE 10 SEC DELAY
25 cm N.C.
12.5 cm N.C.
5 cm N.C.
65 cm N.O.
-10 cm N.O.
5 cm N.O.
12.5 cm N.O.
MINIMUM VENT
HIGH PRESSURE
SUB ATMOSPHERIC PRESSURE
CONT'G PRESSURE POWER SUPPLY
CONT'G PRESSURE DELAY ACTIVATING SWITCH

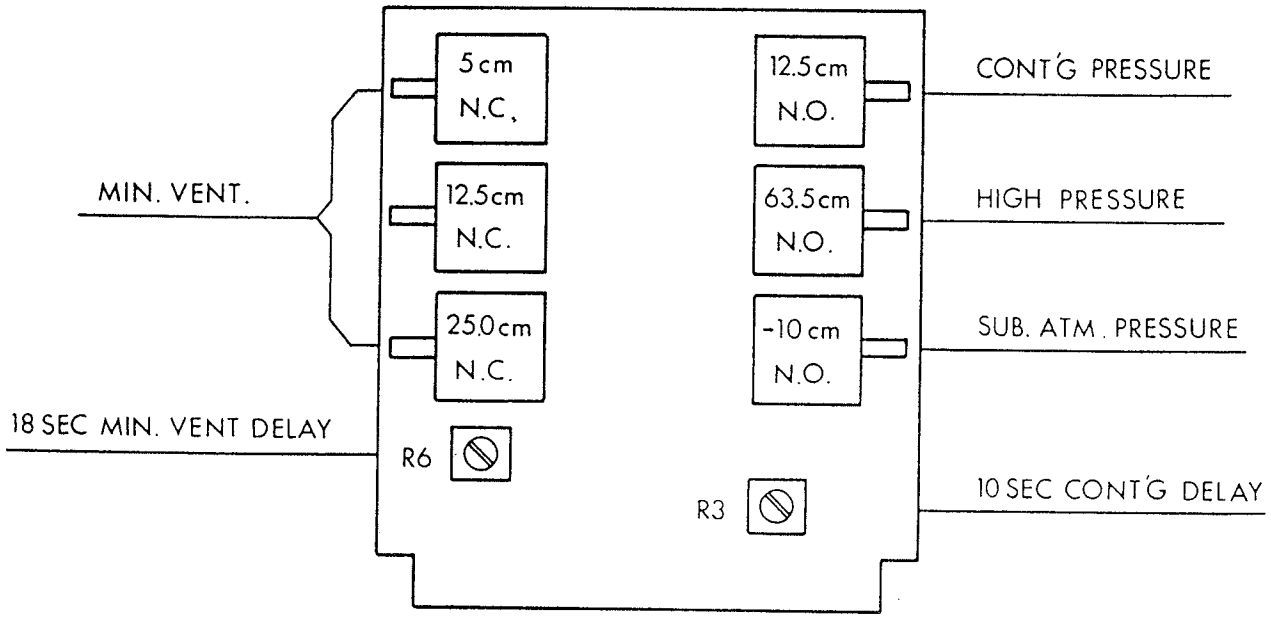
DPM-S

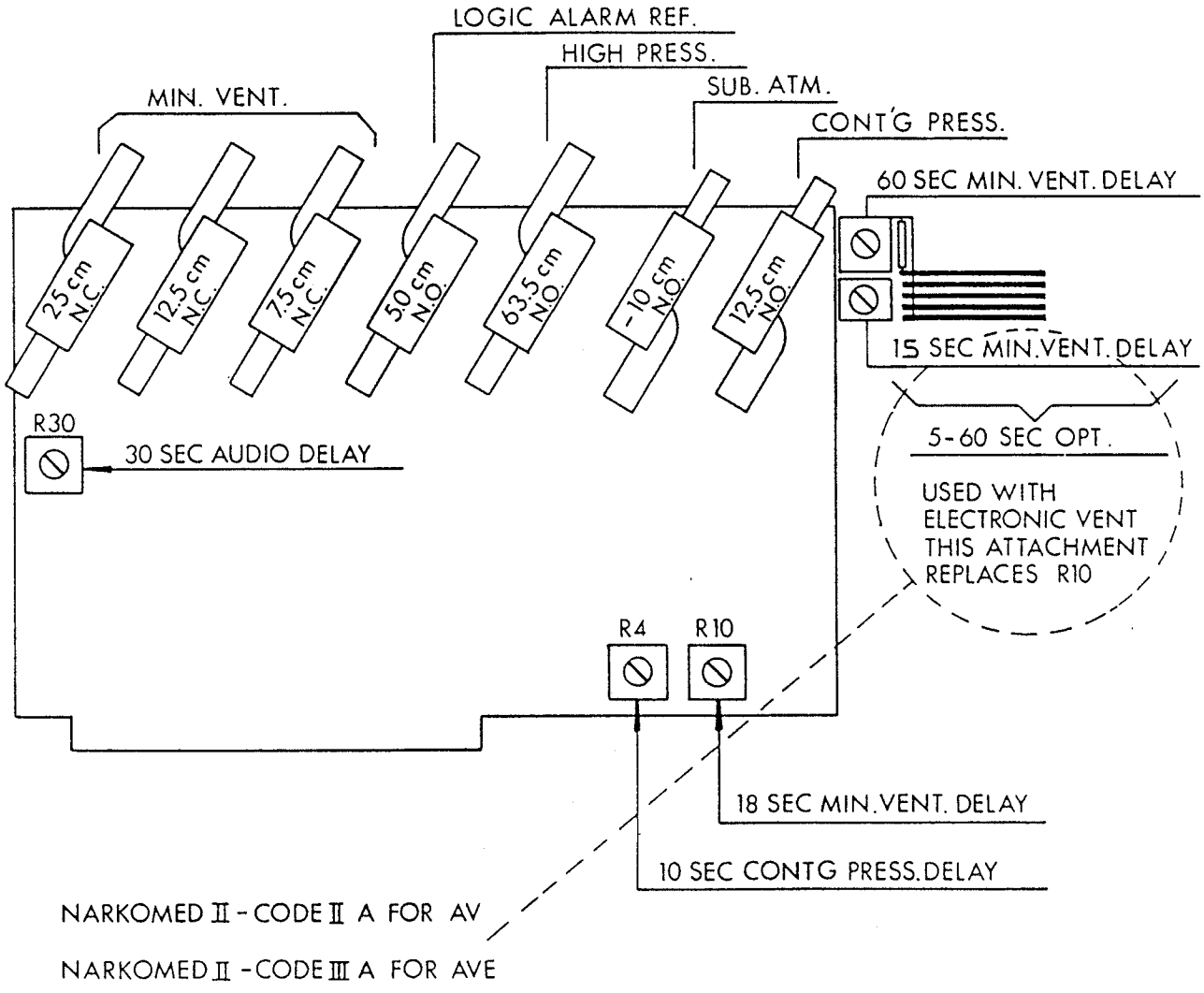

25cm
N.O.
12.5cm
N.O.
7.5cm
N.O.
65cm
N.O.
-10cm
N.O.
15cm
N.O.
MINIMUM VENT
HIGH PRESSURE
SUB. ATM. PRESSURE
CONT'G PRESSURE

AM III

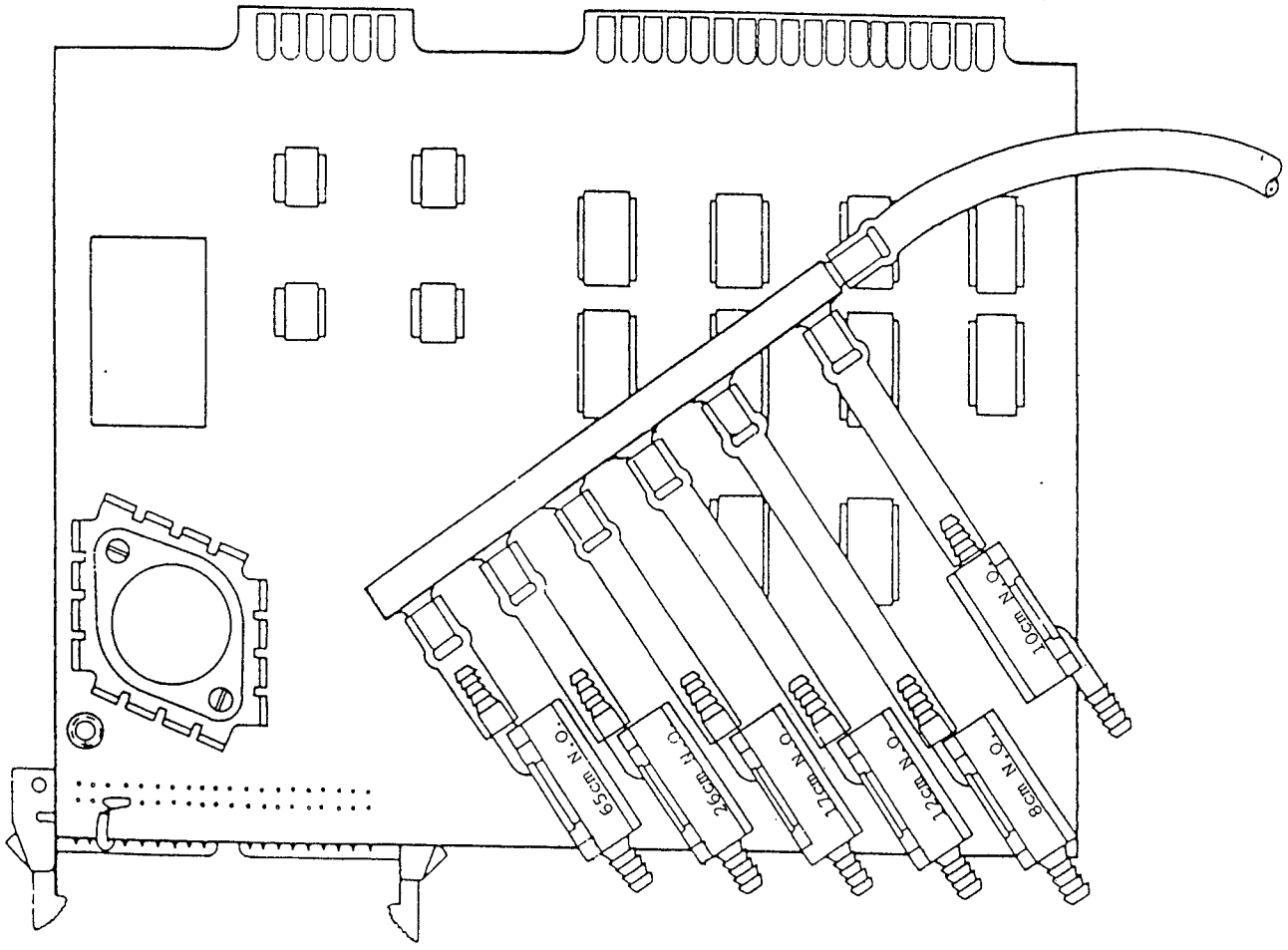

MIN. VENT.
5.0 cm
N.C.
12.5 cm
N.C.
25.0 cm
N.C.
18 SEC MINIMUM DELAY
25.0 cm
N.O.
LEAK TEST

NARKOMED II - CODE I

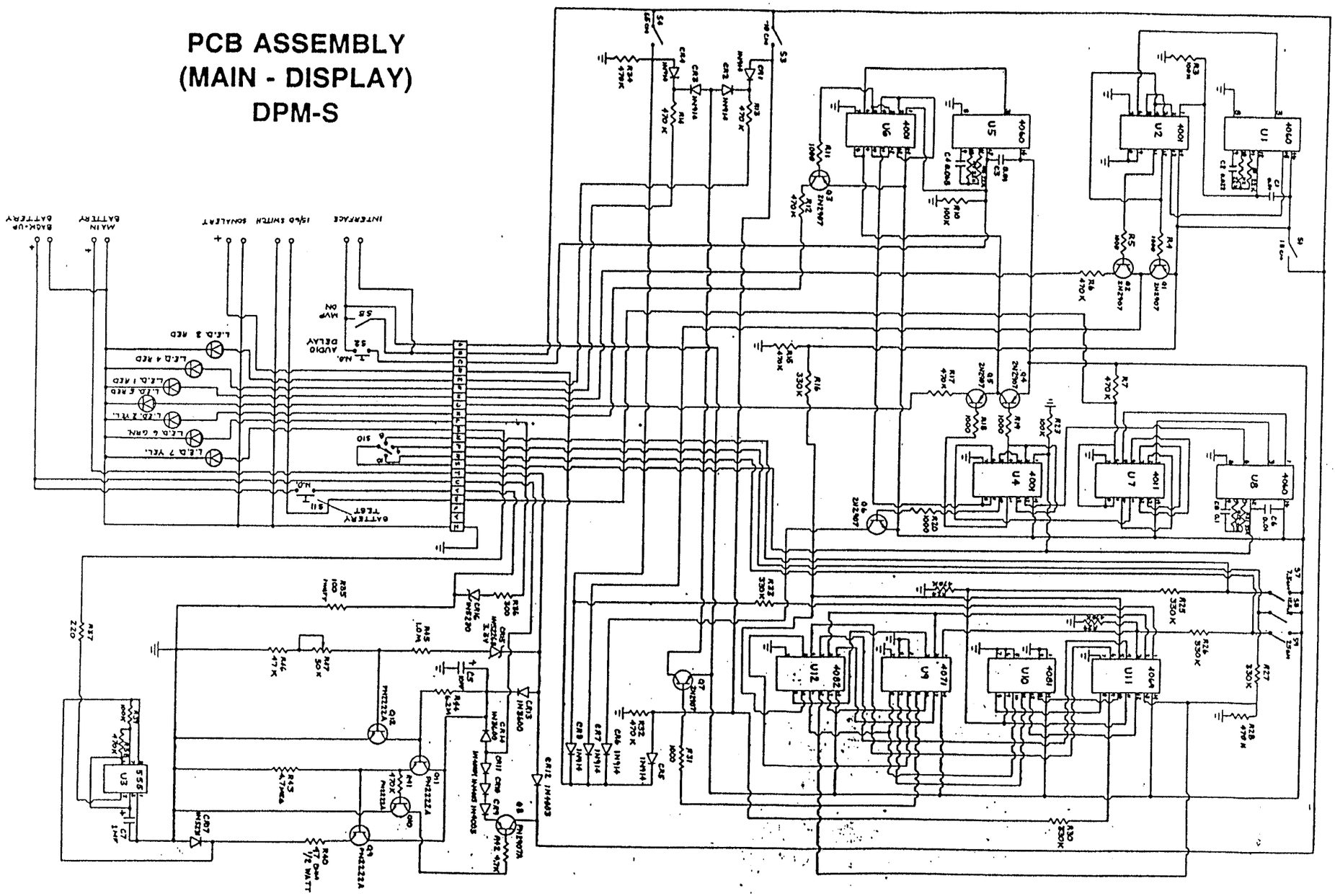


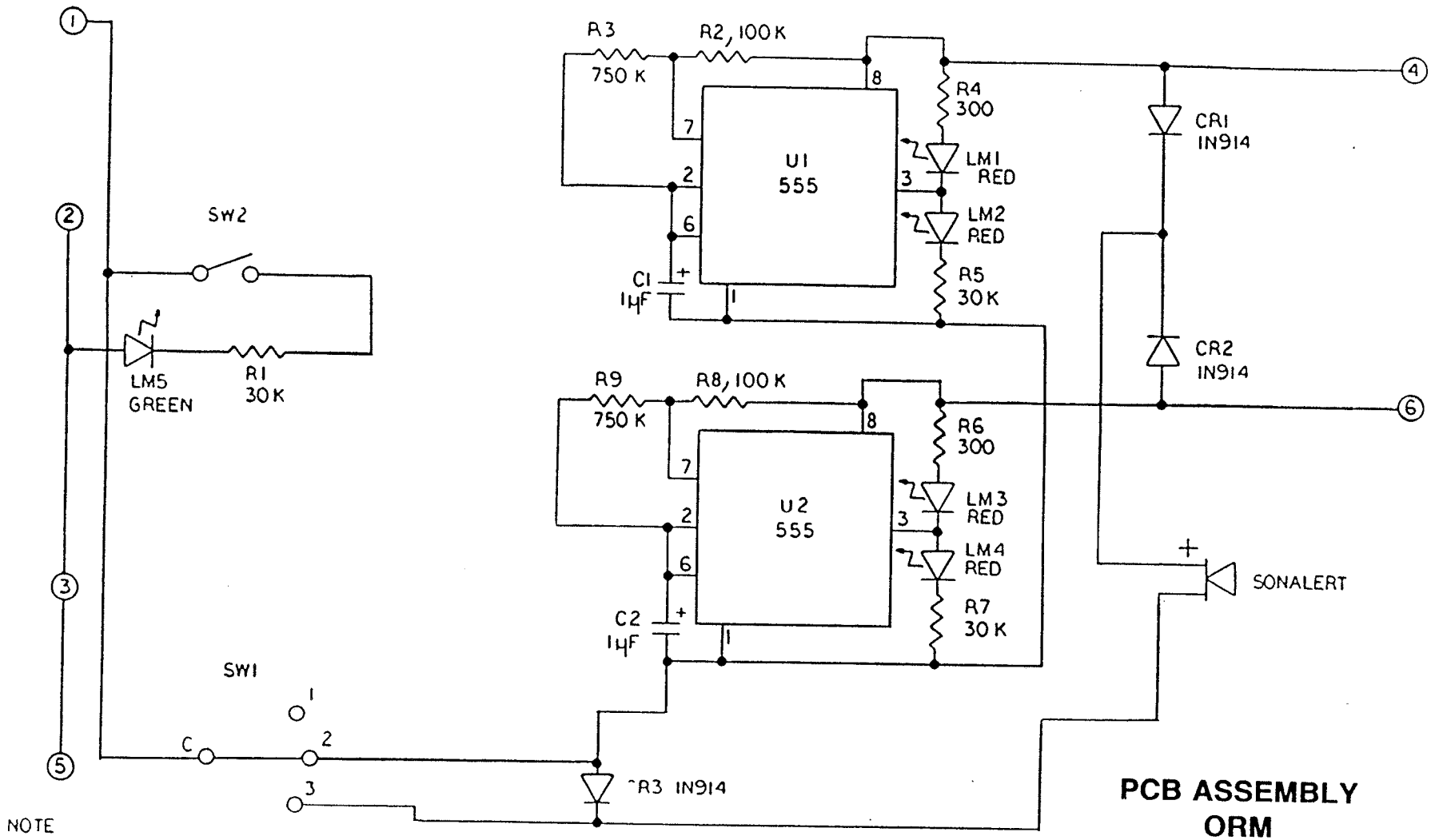

LOGIC ALARM REF.
HIGH PRESS.
SUB. ATM.
CONT'G PRESS.
MIN. VENT.
60 SEC MIN. VENT. DELAY
25 cm N.C.
12.5 cm N.C.
7.5 cm N.C.
5.0 cm N.O.
63.5 cm N.O.
-10 cm N.O.
12.5 cm N.O.
15 SEC MIN.VENT. DELAY
R30
30 SEC AUDIO DELAY
5-60 SEC OPT.
USED WITH ELECTRONIC VENT THIS ATTACHMENT REPLACES R10
R4
R10
18 SEC MIN.VENT. DELAY
10 SEC CONTG PRESS.DELAY
NARKOMED II - CODE II A FOR AV
NARKOMED II - CODE III A FOR AVE

PRINTED CIRCUIT BOARD ASSEMBLY - NM2A



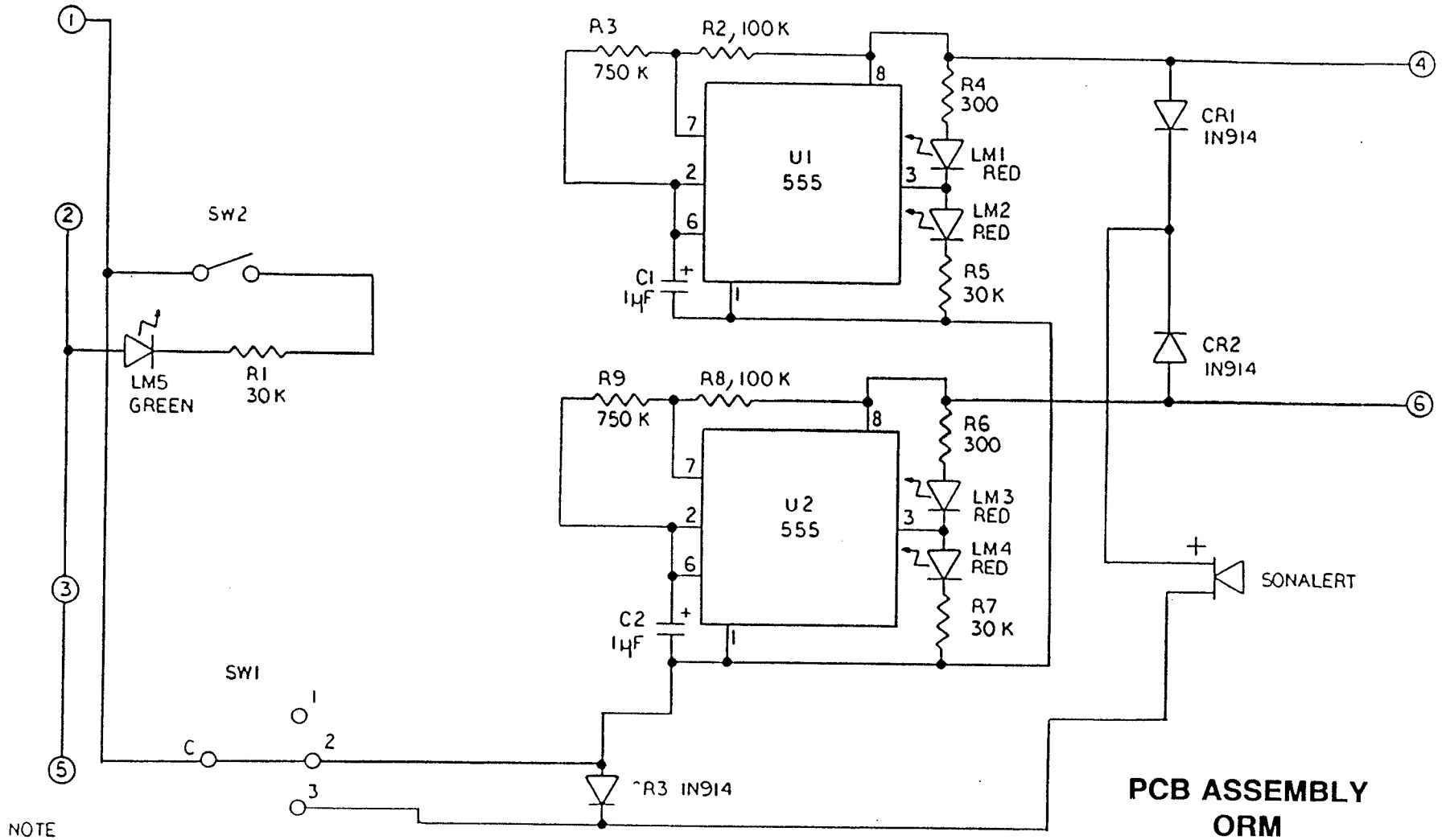
PCB ASSEMBLY
(MAIN - DISPLAY)
DPM-S





PCB ASSEMBLY
ORM

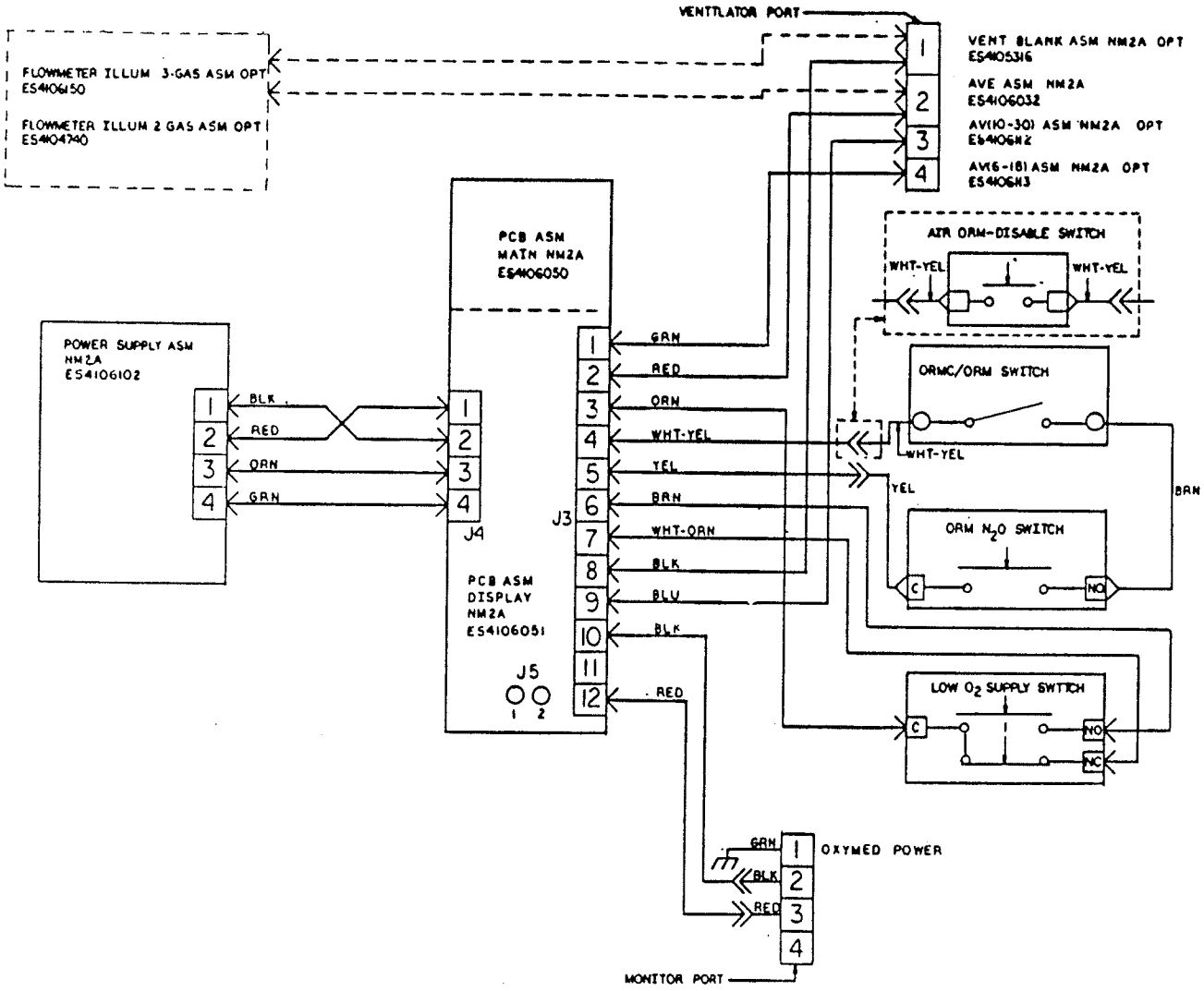
NOTE
ALL RESISTORS ARE 1/4 WATT, 5% TOL., CARBON FILM UNLESS OTHERWISE SPECIFIED

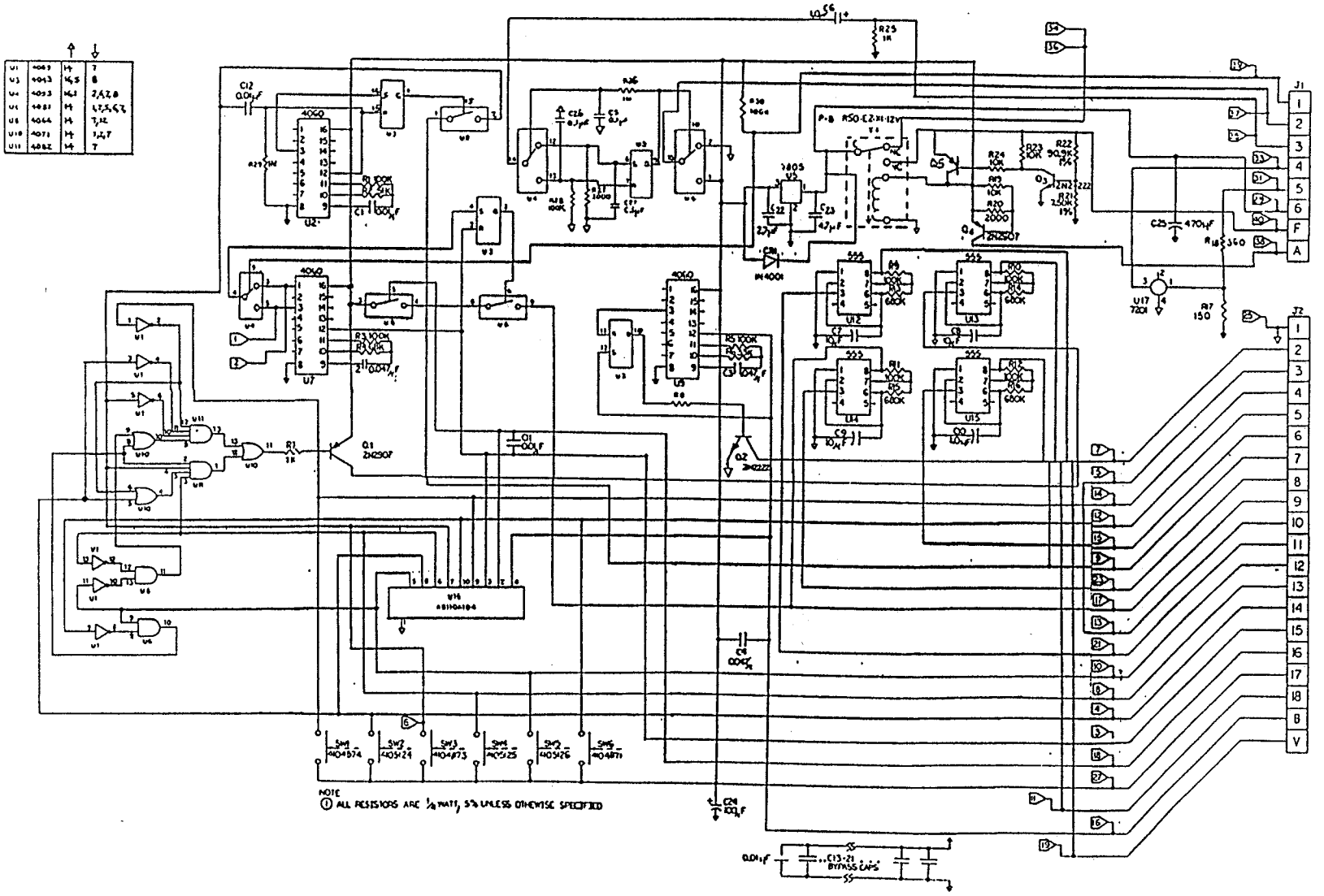


PCB ASSEMBLY
ORM

NOTE
ALL RESISTORS ARE 1/4 WATT, 5% TOL., CARBON FILM UNLESS OTHERWISE SPECIFIED

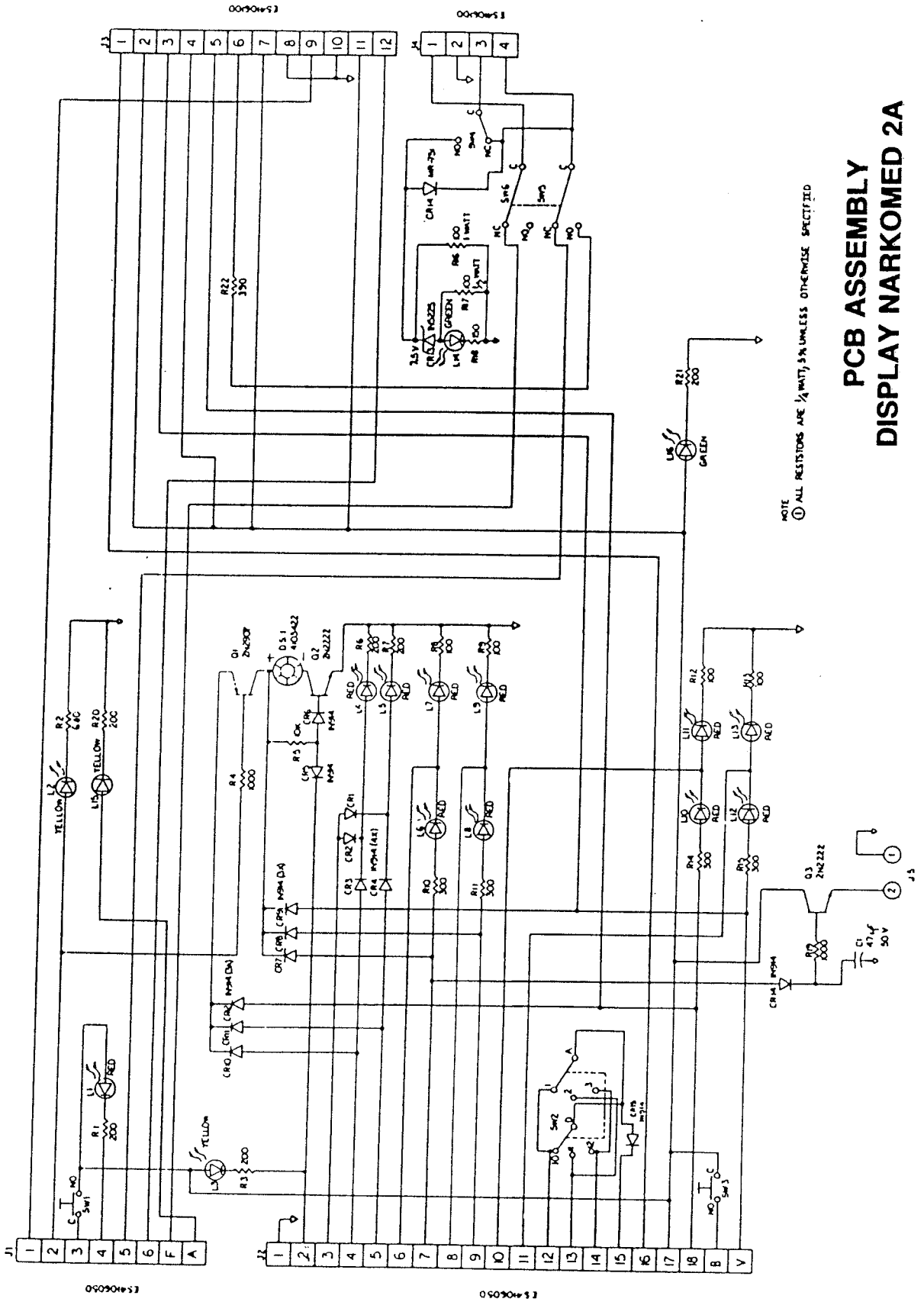
NARKOMED 2A ASSEMBLY

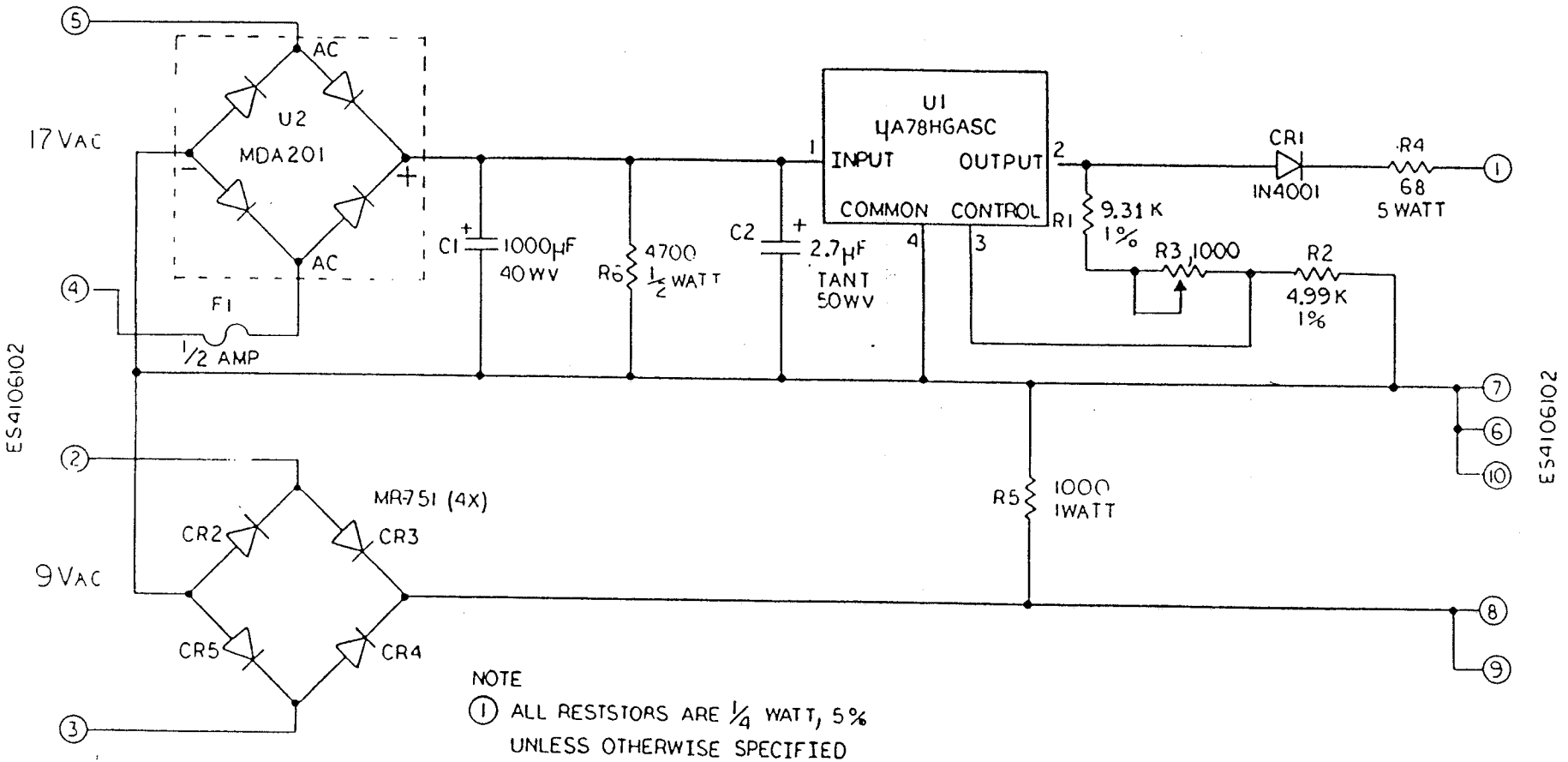




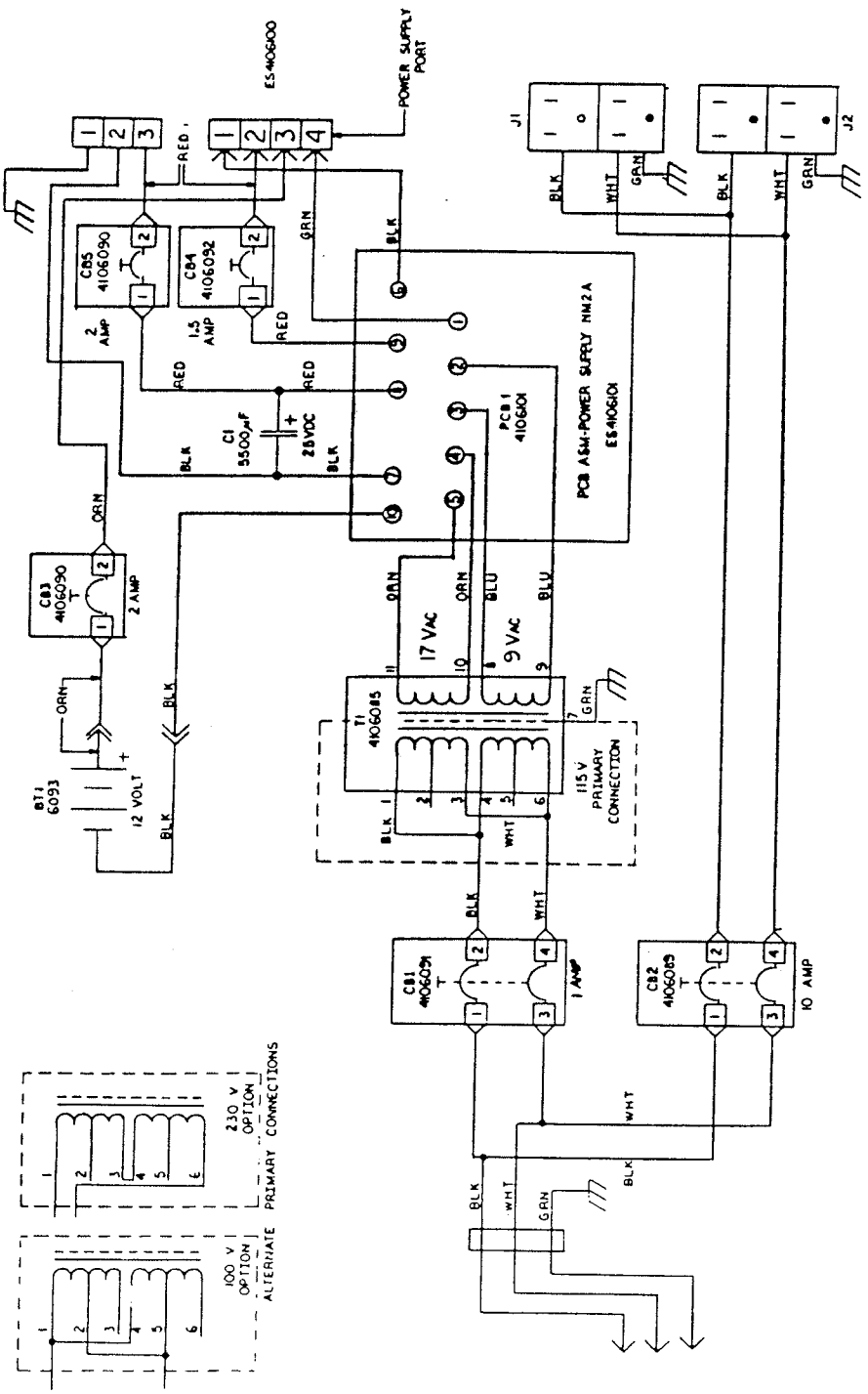
NOTE
① ALL RESISTORS ARE 1/8 WATT, 5% UNLESS OTHERWISE SPECIFIED

PCB ASSEMBLY
MAIN NARKOMED 2A

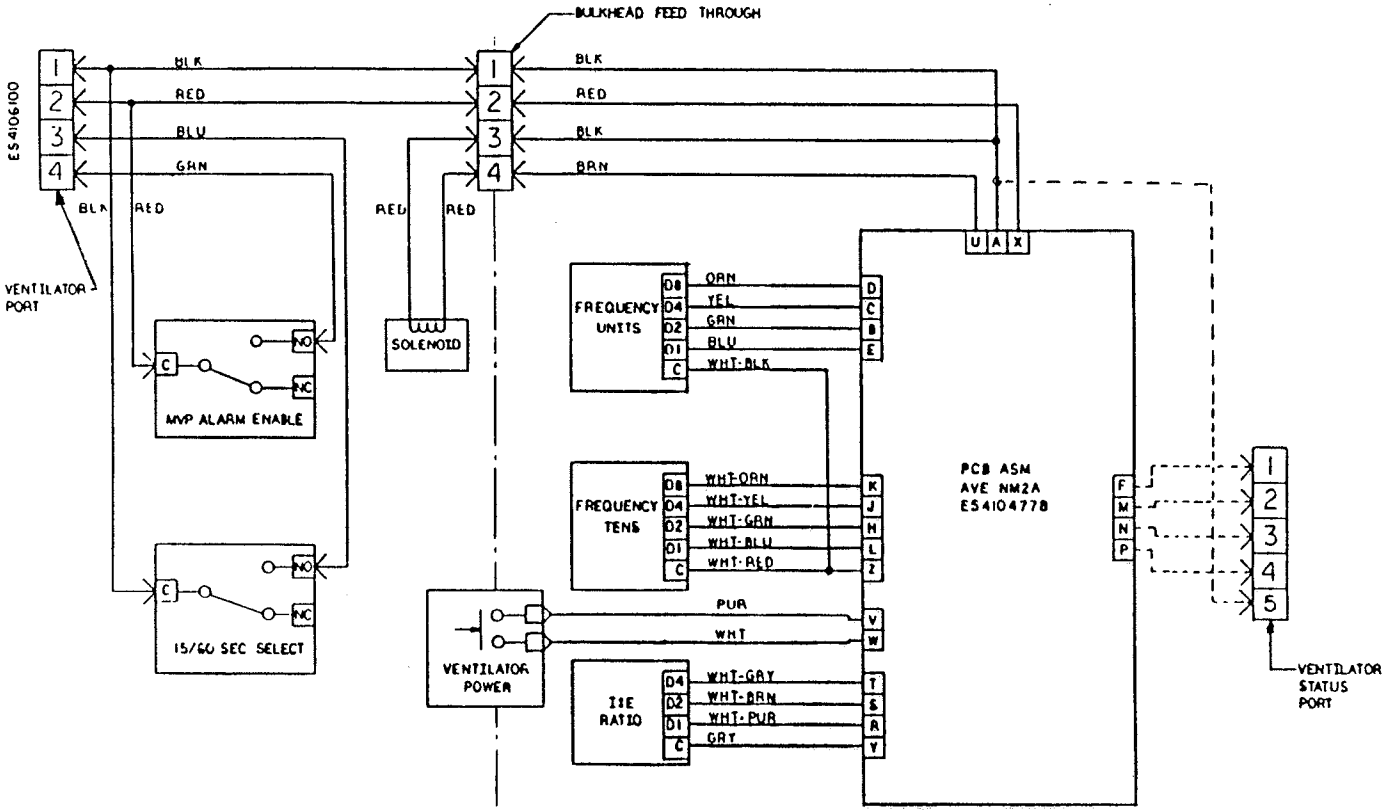

PCB ASSEMBLY
DISPLAY NARKOMED 2A
NOTE
① ALL RESISTORS ARE ¼ WATT, 5% UNLESS OTHERWISE SPECIFIED



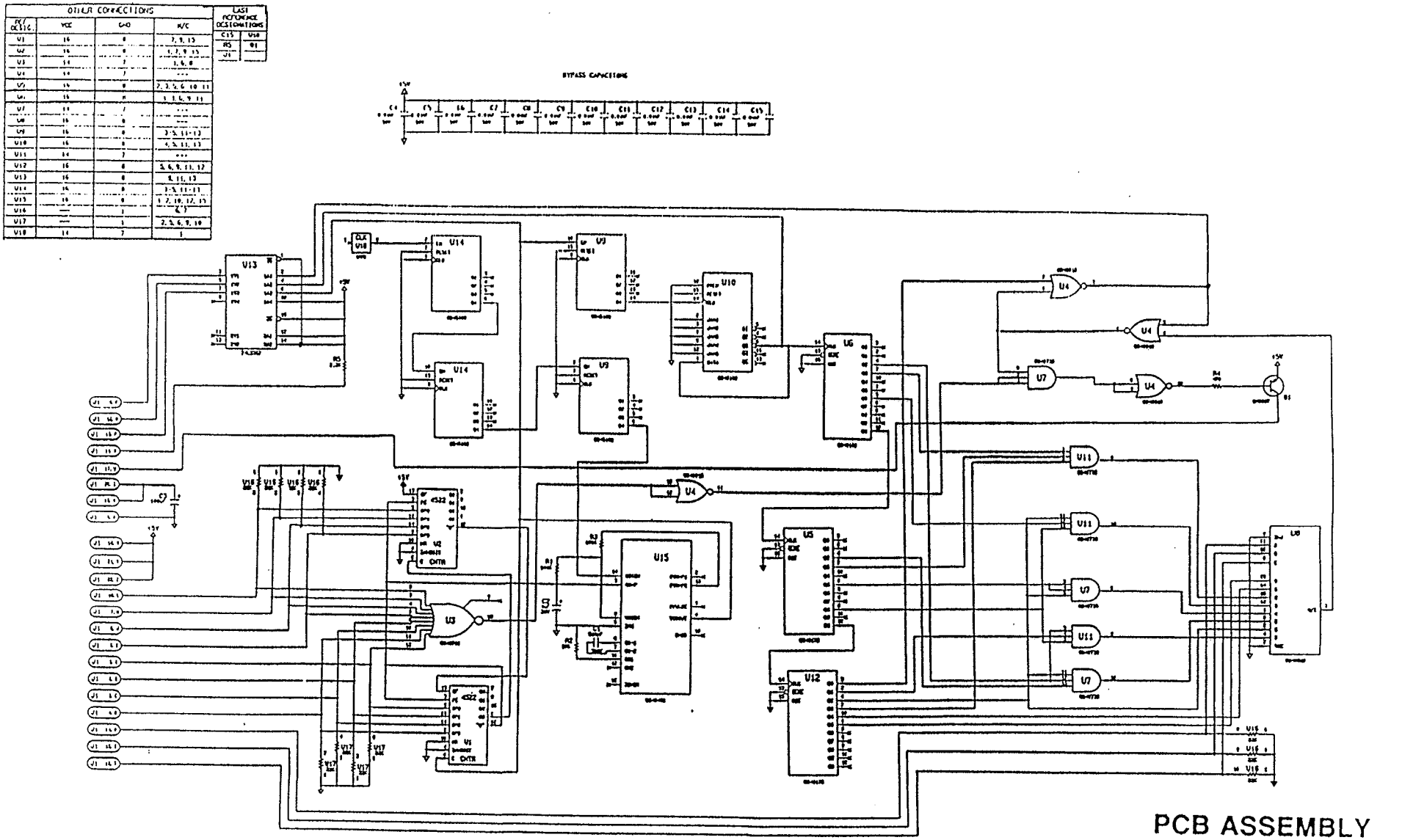
PCB ASSEMBLY
POWER SUPPLY NARKOMED 2A

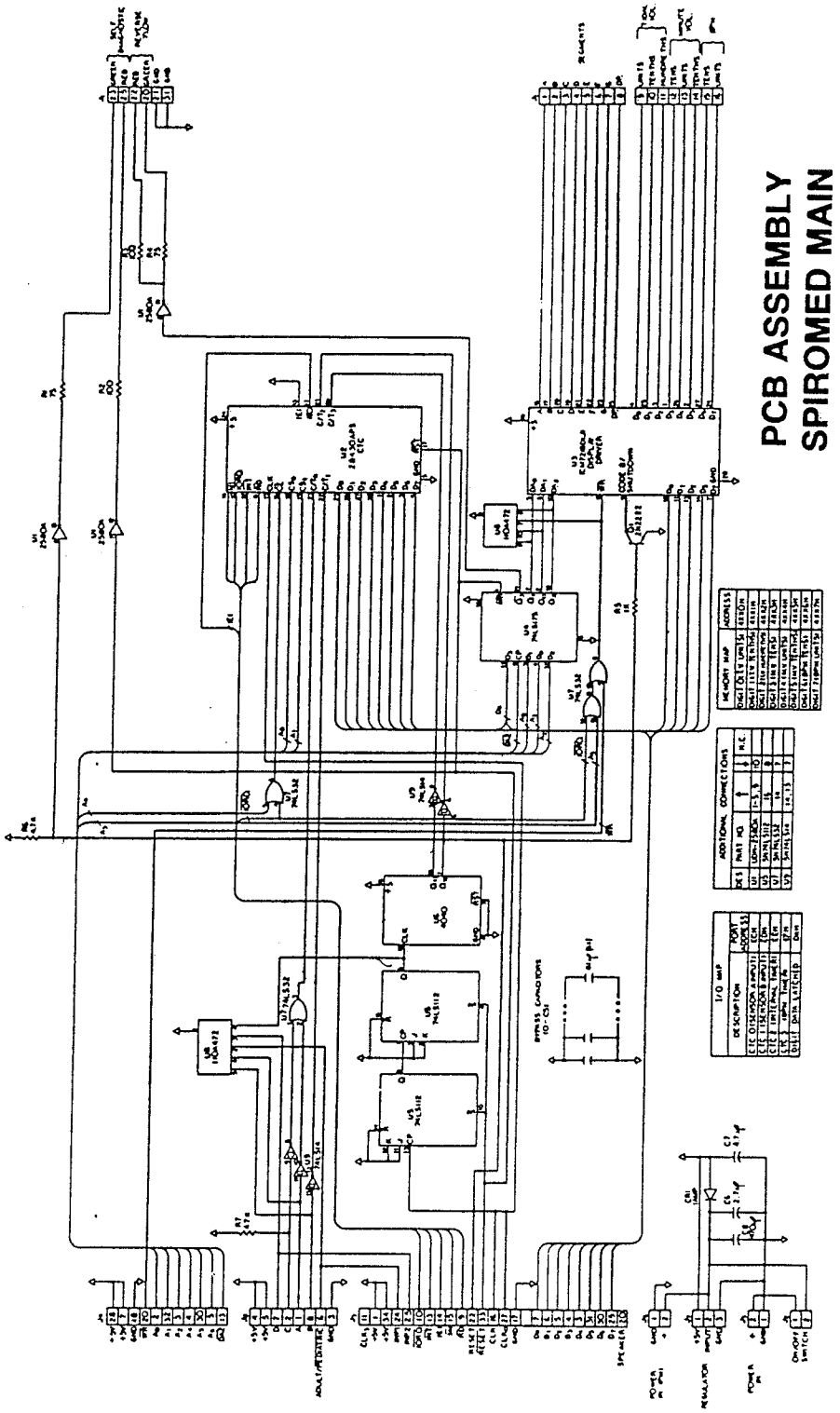


POWER SUPPLY ASSEMBLY NARKOMED 2A

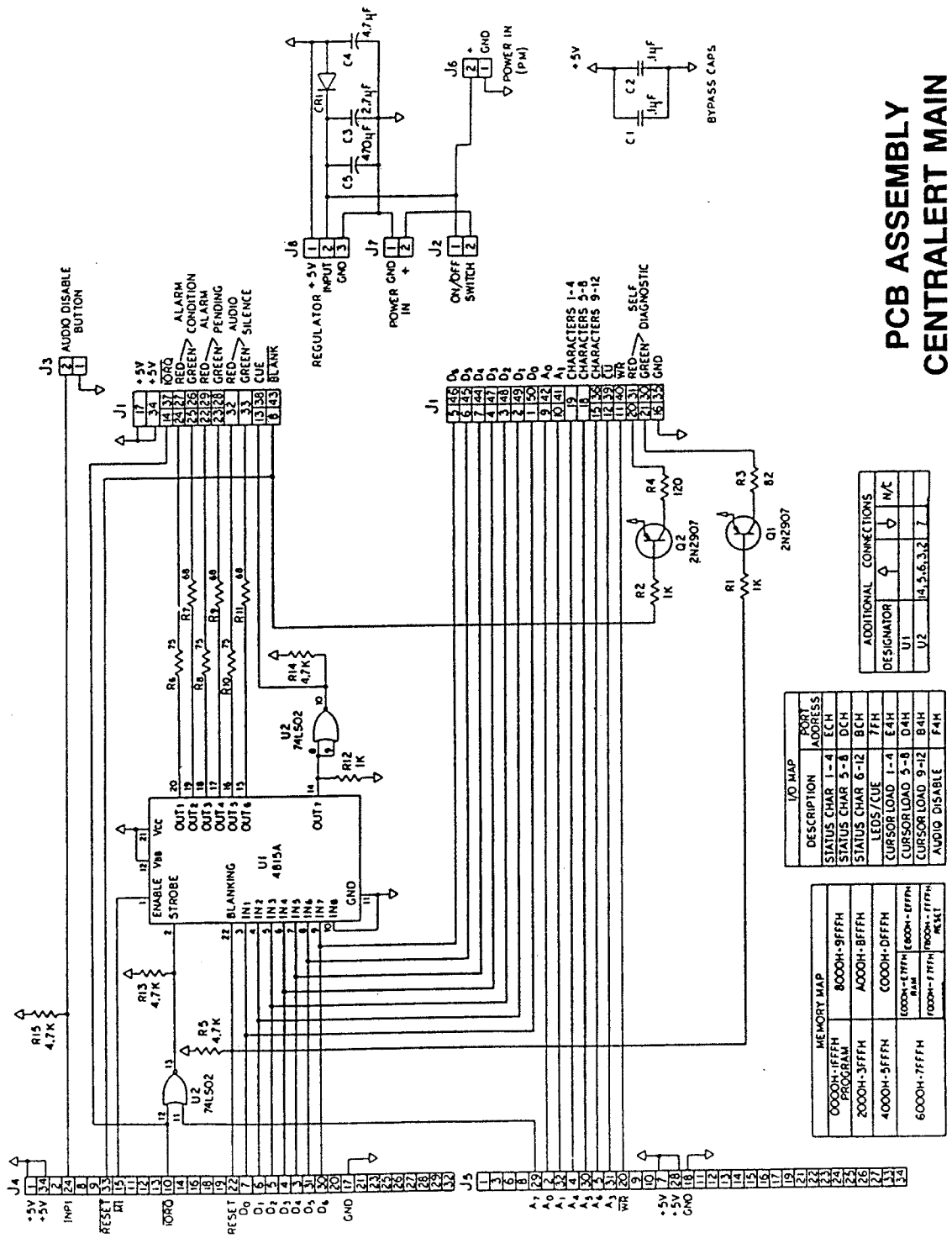


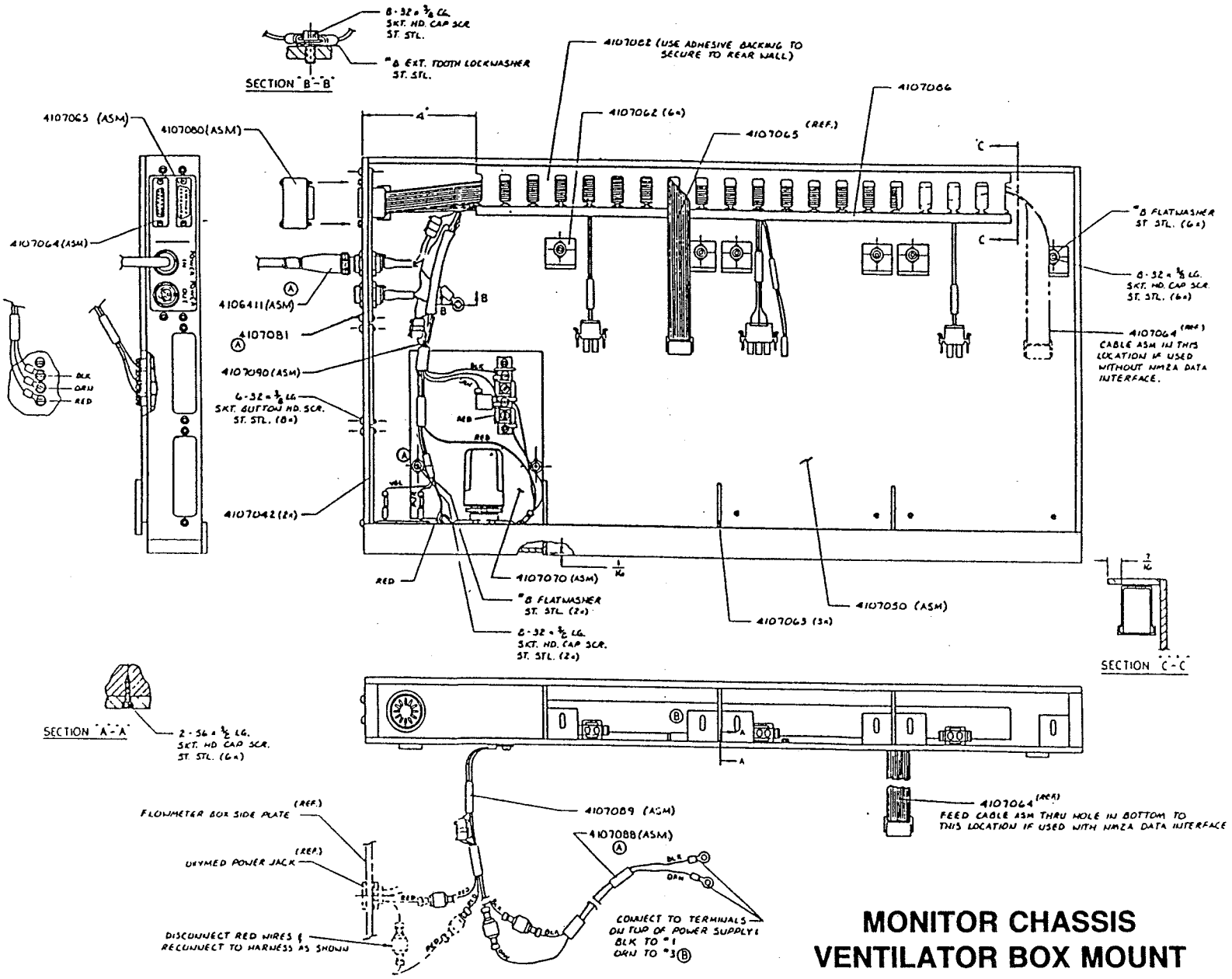
AVE ASSEMBLY
NARKOMED 2A


OTHER CONNECTIONS
LAST PCB/PANEL DESIGNATIONS
BYPASS CAPACITORS
PCB ASSEMBLY
AVE NARKOMED 2A



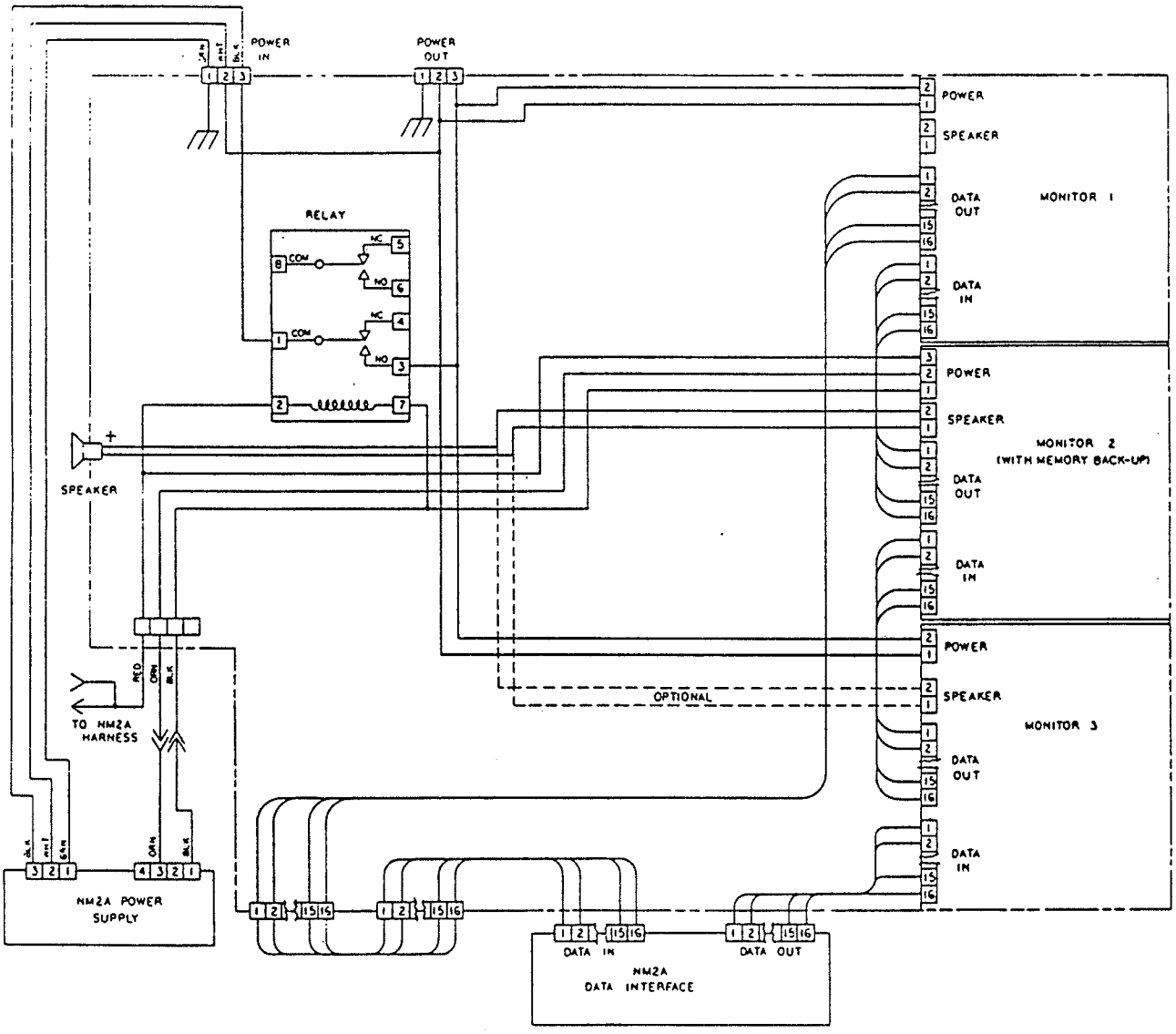
PCB ASSEMBLY
SPIROMED MAIN

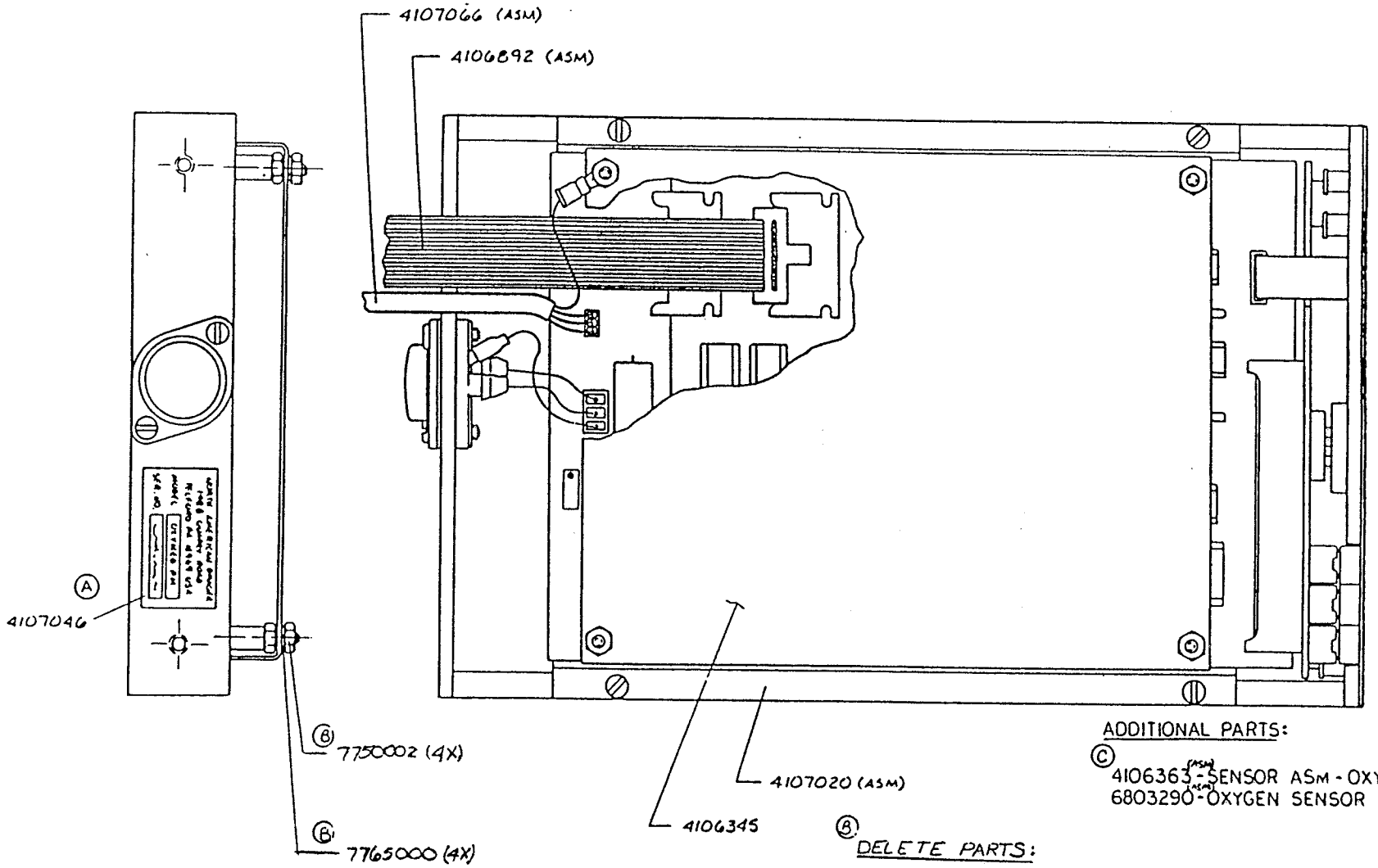

PCB ASSEMBLY
CENTRALERT MAIN
I/O MAP
DESCRIPTION
PORT ADDRESS
STATUS CHAR 1-4 ECH
STATUS CHAR 5-8 DCH
STATUS CHAR 6-12 BCH
LEDS/CUE 7FH
CURSOR LOAD 1-4 E4H
CURSOR LOAD 5-8 D4H
CURSOR LOAD 9-12 B4H
AUDIO DISABLE F4H
MEMORY MAP
0000H-1FFFH PROGRAM
2000H-3FFFH
4000H-5FFFH
6000H-7FFFH
8000H-9FFFH
A000H-BFFFH
C000H-DFFFH
E000H-EFFFH
F000H-FFFFH
ADDITIONAL CONNECTIONS
DESIGNATOR
U1
U2
N/C
REGULATOR +5V
POWER IN (PW)
BYPASS CAPS
AUDIO DISABLE BUTTON
ON/OFF SWITCH
POWER GND IN
ALARM CONDITION
ALARM PENDING
AUDIO SILENCE
CUE
BLANK
CHARACTERS 1-4
CHARACTERS 5-8
CHARACTERS 9-12
SELF DIAGNOSTIC
74LS02
4815A
2N2907



MONITOR CHASSIS VENTILATOR BOX MOUNT

MONITOR CHASSIS
VENTILATOR BOX MOUNT





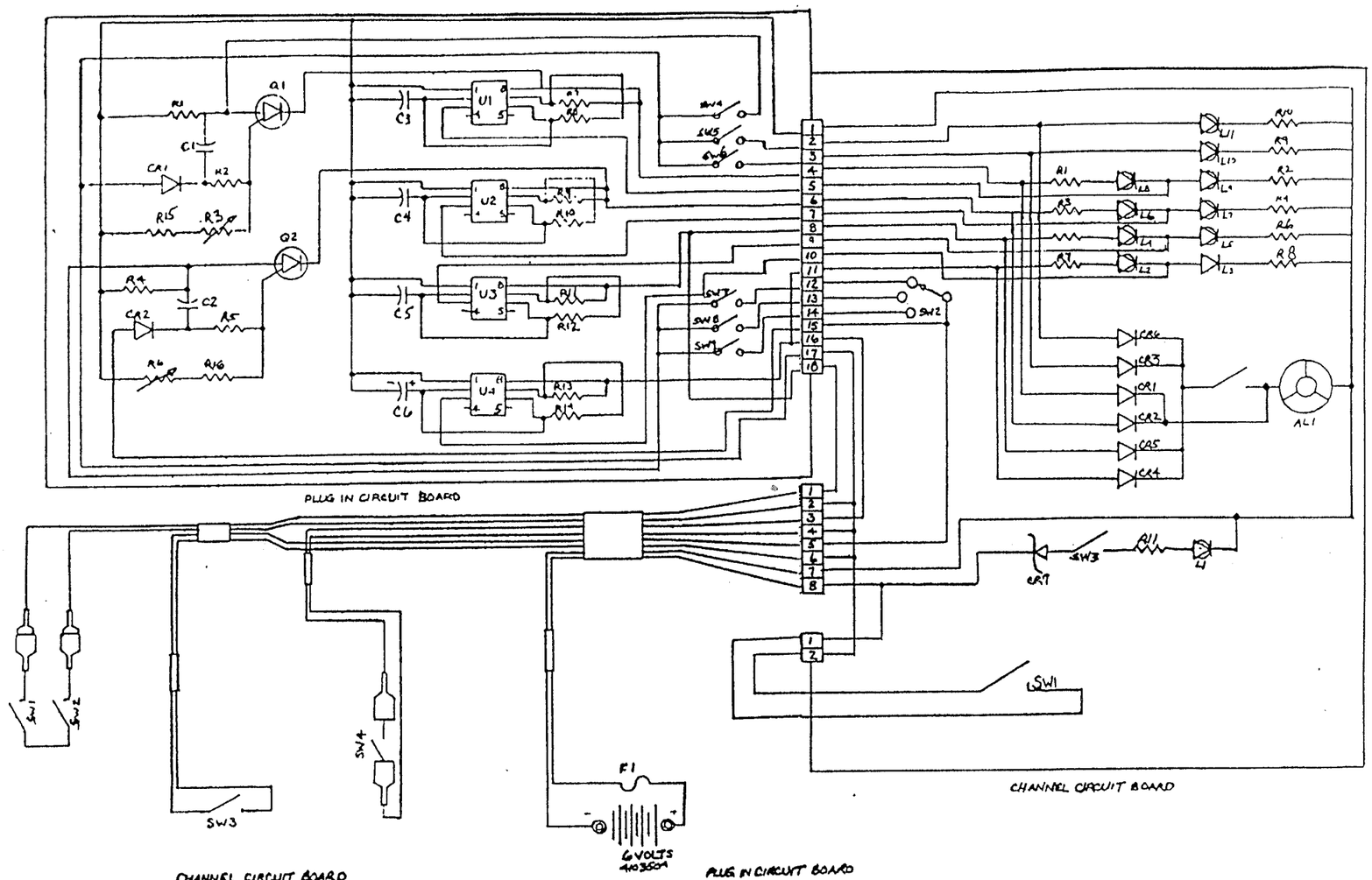
ADDITIONAL PARTS:

(C) 4106363 (ASM) - SENSOR ASM - OXYMED/OXYDIG
6803290 (ASM) - OXYGEN SENSOR CAPSULE

(B) DELETE PARTS:

4107042 - PANEL - MONITOR INTERFACE - BLANK

OXYMED (PM)



CHANNEL CIRCUIT BOARD

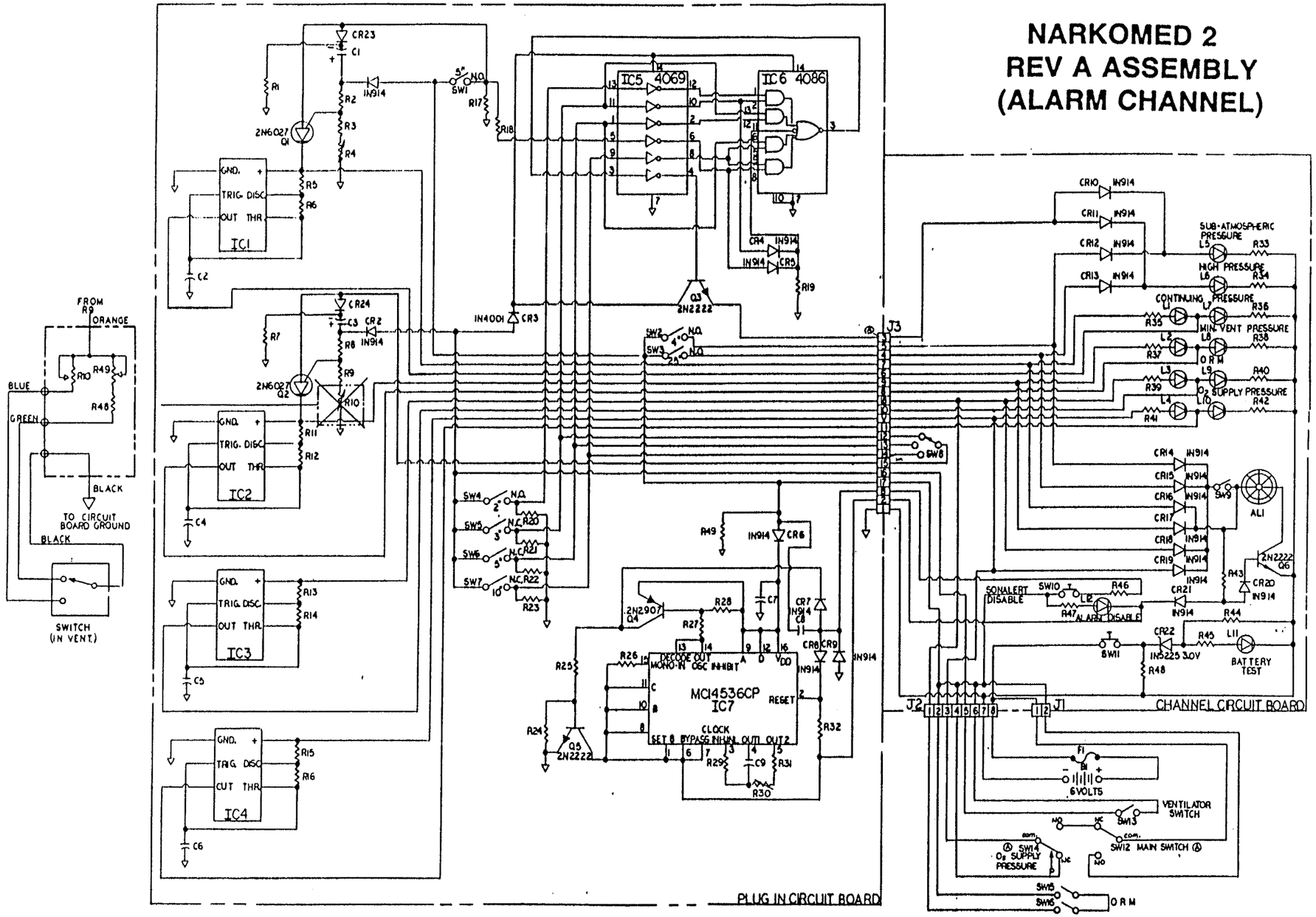
CODE	DESCRIPTION	PART NO.	TOLERANCE	VALUE	NOTES
R1,R3,R5,R7	RESISTOR		±5%	300 OHMS	
R2,R4,R6,R8	RESISTOR		±5%	100 OHMS	
R9, R10, R11	RESISTOR		±5%	100 OHMS	
CR1 - CR6	CRYSTAL DIODE	1N914			
SW1	ON-OFF SWITCH				125V AC
SW2	3 POSITION SWITCH	4103539			
SW3	PUSH BUTTON SWITCH				
L1	GREEN LIGHT EMITTING DIODE				
L2 - L11	RED LIGHT EMITTING DIODE				
AL1	ANNUNCIATOR	4103512			
MISC.					
SW1	ORM SWITCH	4103480			
SW2	DEMART SWITCH 2°N.C.	4103687			
SW3	ELECTRICAL SWITCH	4103541			
SW4	PRESSURE SWITCH	4103406		-30	
F1	FUSE	4103417		250 mA	

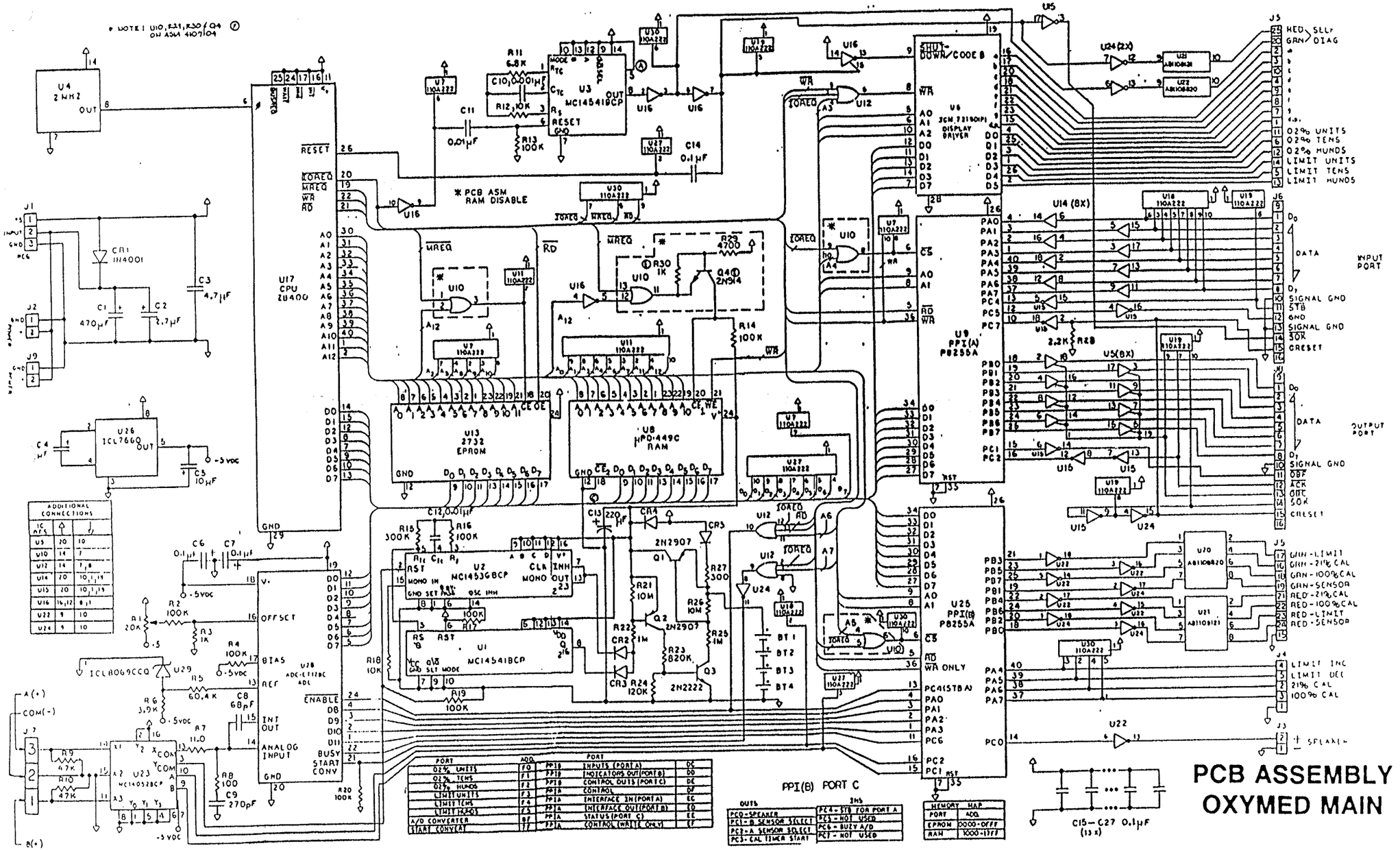
PLUG IN CIRCUIT BOARD

CODE	DESCRIPTION	PART NO.	TOLERANCE	VALUE	NOTES
R1,R4,R5,R6	RESISTOR		±5%	10 K	
R2, R5	RESISTOR		±5%	33K	
R3,R6	VARIABLE RESISTOR			0-500K	
R7,R9,R11,R13	RESISTOR		±5%	100K	
R8,R10,R12,R14	RESISTOR		±5%	680K	
CR1,CR2	CRYSTAL DIODE	1N914			
Q1,Q2	TRANSISTOR	2N6027			
C1,C2	CAPACITOR			600MF	25VOLTS
U1-U4	INTEGRATED CIRCUIT	UA555TC		RPM	
SW4	DEMART SWITCH 5°N.O.	4104326			
SW5	DEMART SWITCH 4°N.O.	4104327			
SW6	DEMART SWITCH 25°N.O.	4104334			
SW7	DEMART SWITCH 2°N.C.	4103687			
SW8	DEMART SWITCH 5°N.C.	4104324			
SW9	DEMART SWITCH 10°N.C.	4104325			
C3-C6	CAPACITOR			1MF	0-50 VOLTS
CR7	ZENER DIODE	IN4734A			

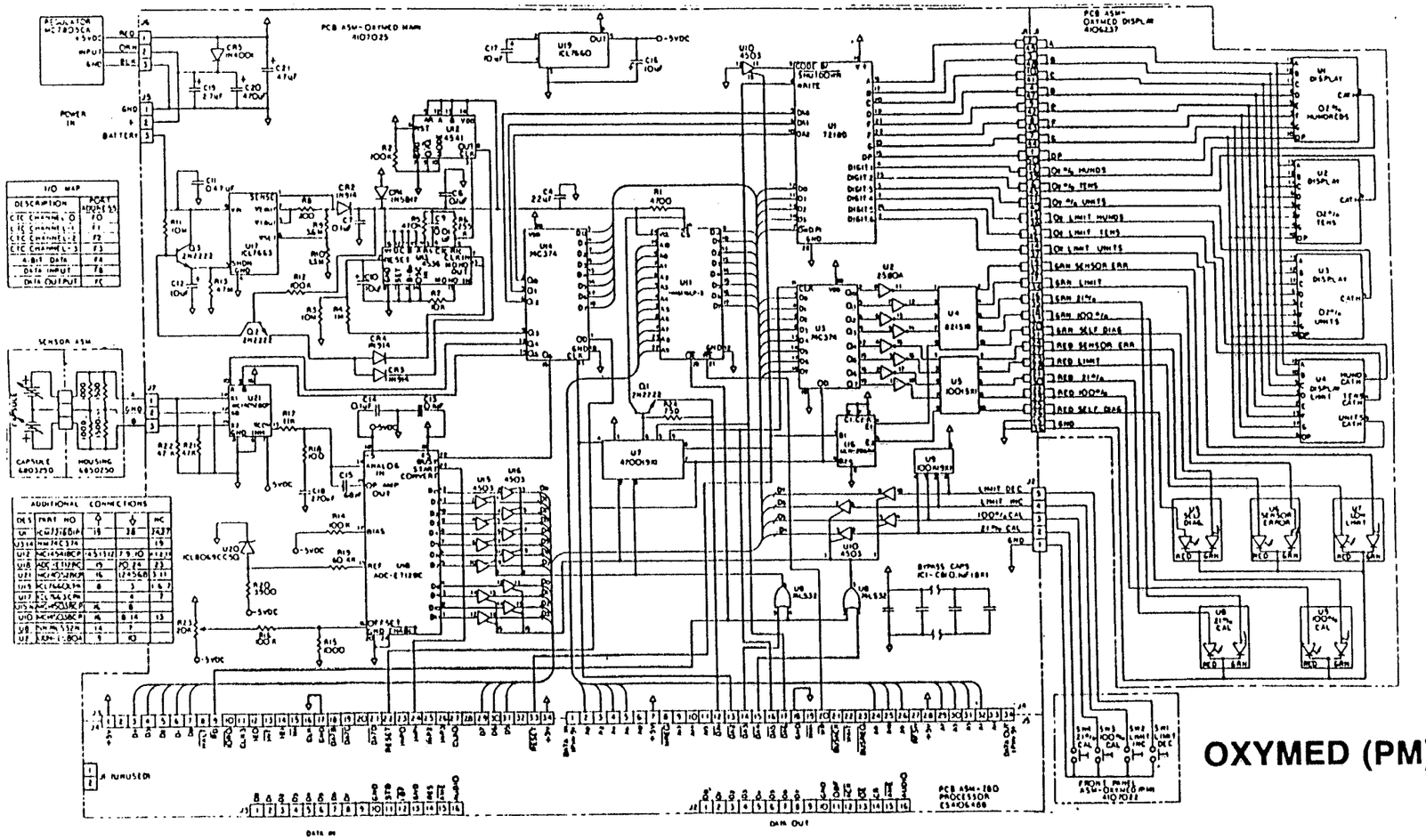
NARKOMED II
WIRING

NARKOMED 2
REV A ASSEMBLY
(ALARM CHANNEL)

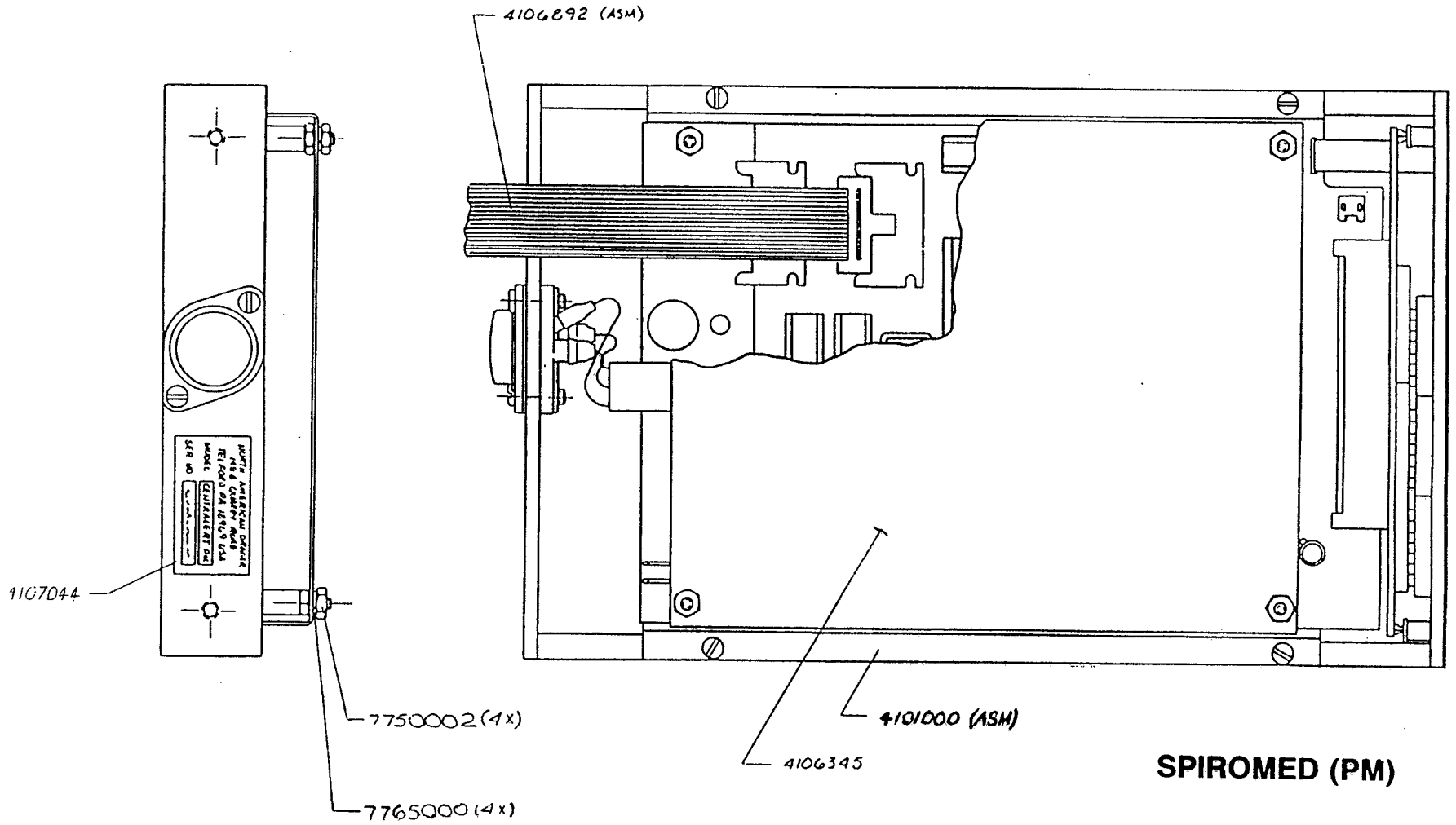




PCB ASSEMBLY OXYMED MAIN

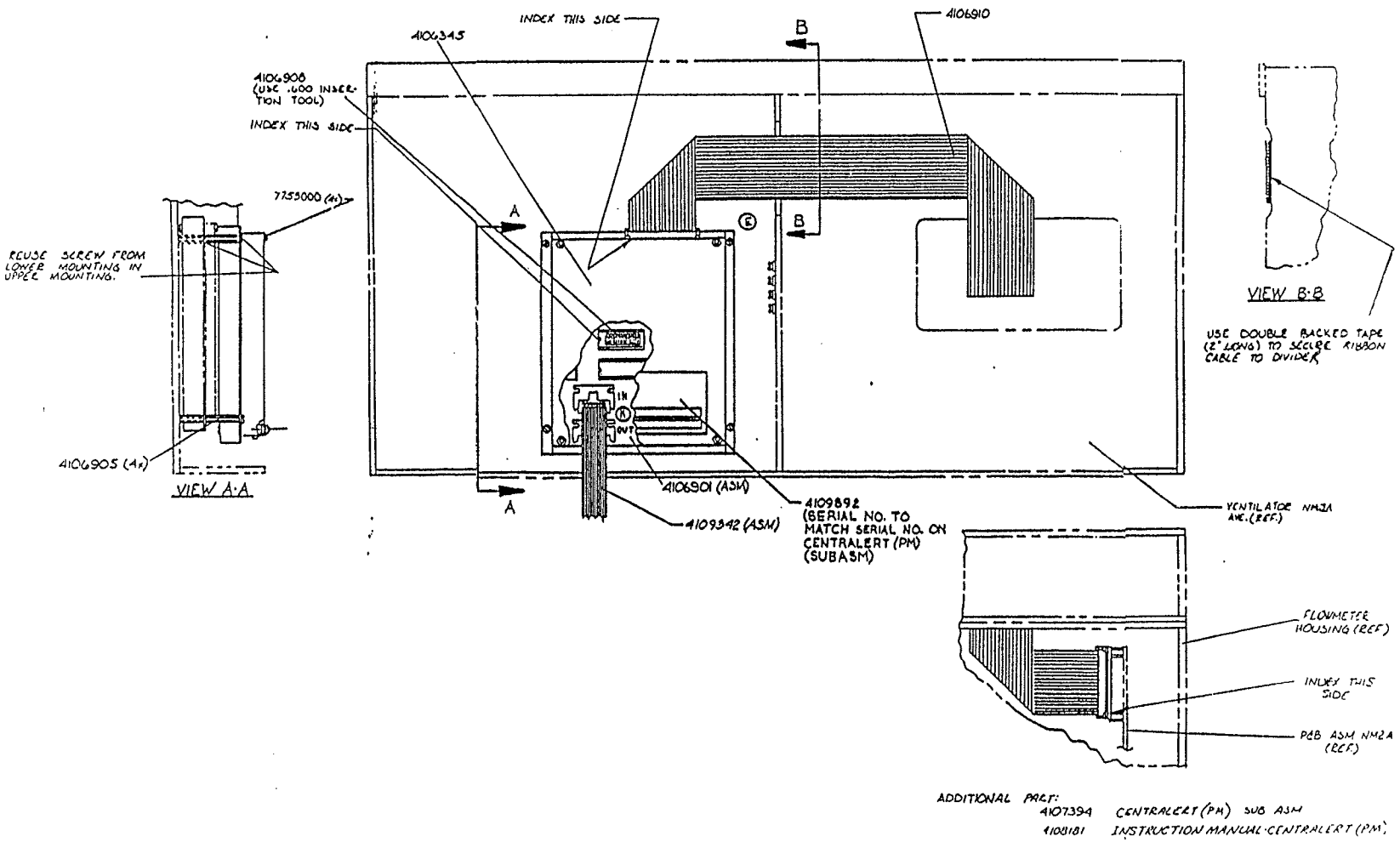


OXYMED (PM)



SPIROMED (PM)

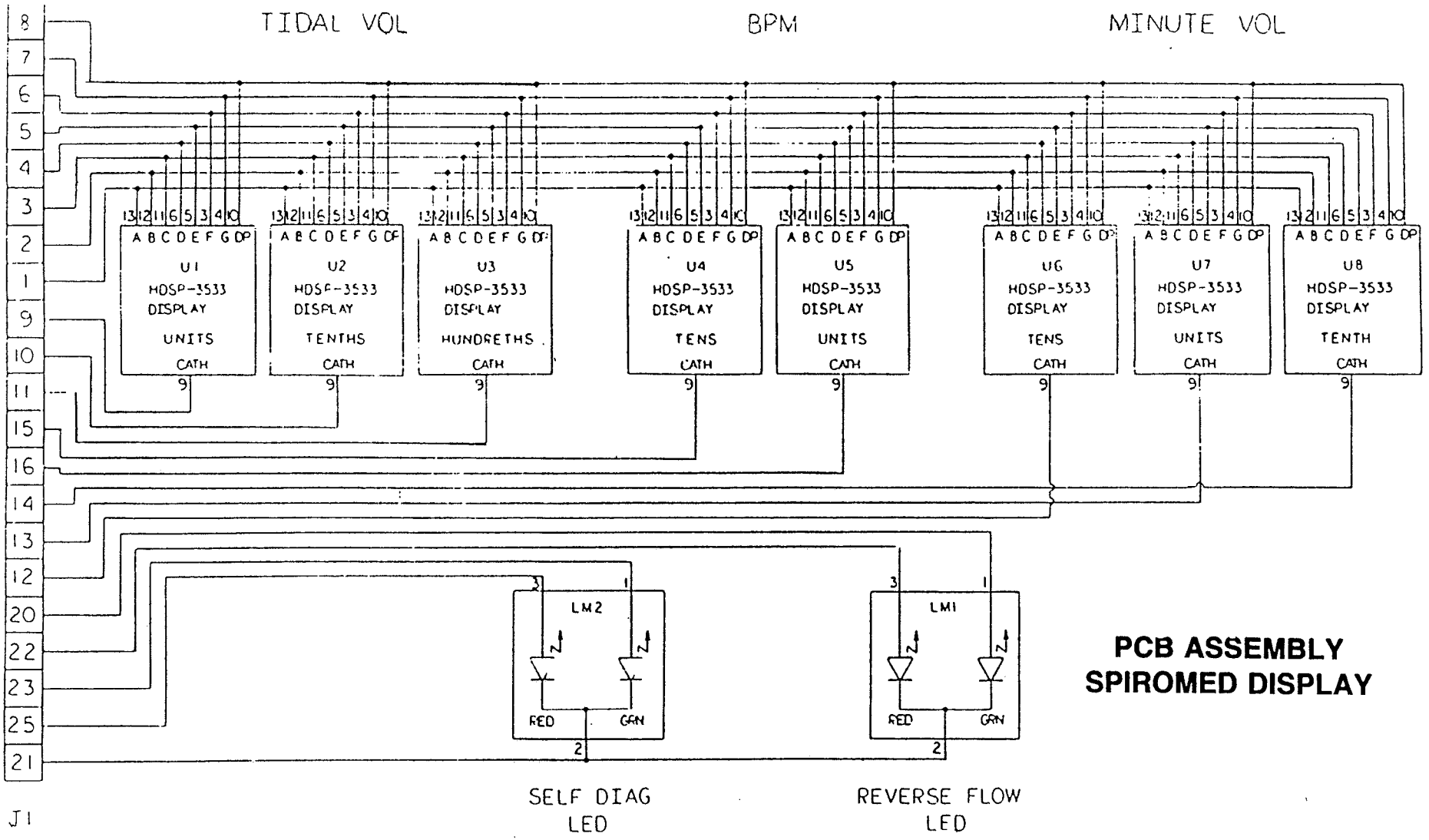
ADDITIONAL PART:
4106362 SENSOR ASM - SPIROMED



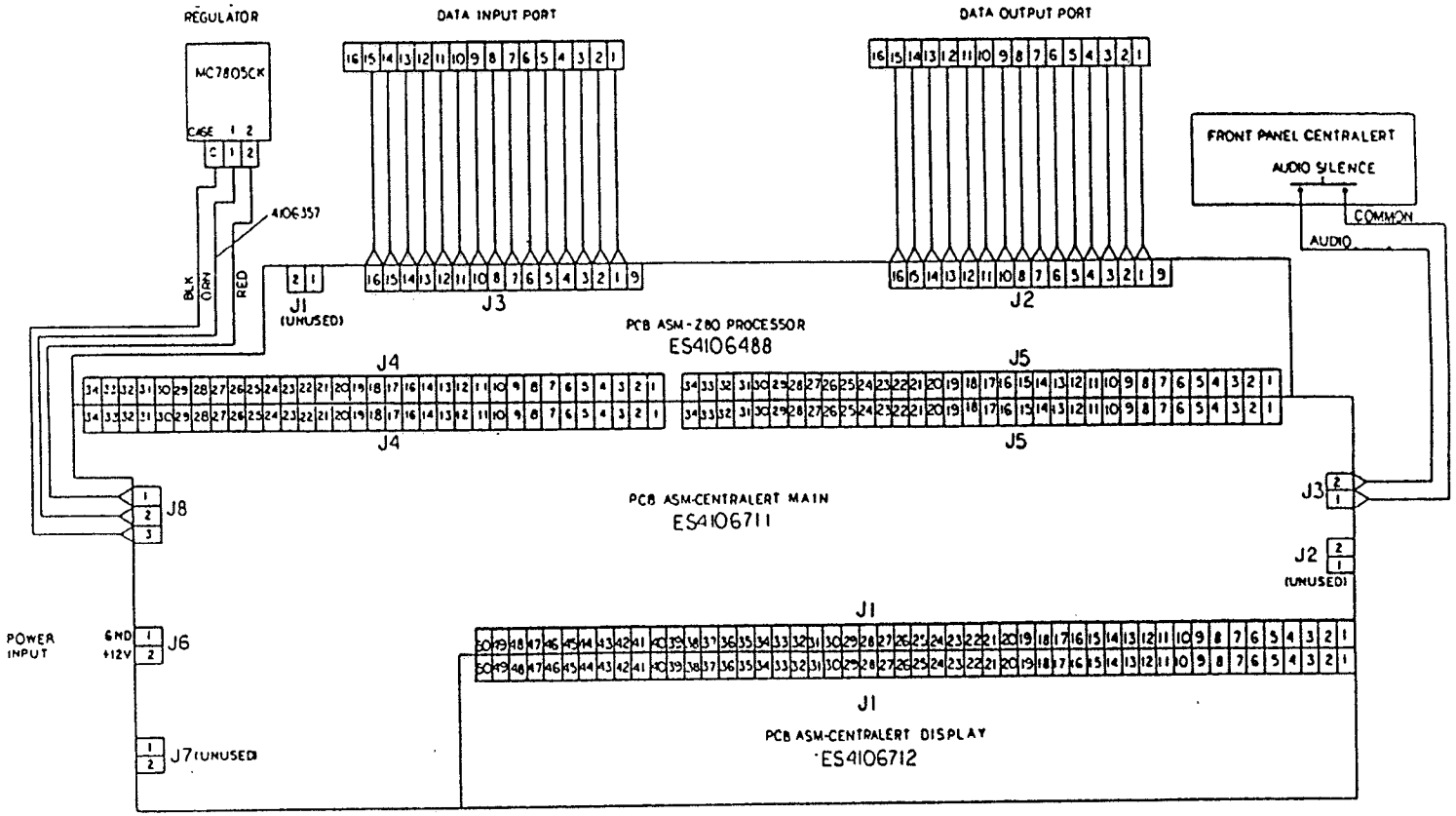
ADDITIONAL PART:

4107394	CENTRALERT (PM) SUB ASM
4108181	INSTRUCTION MANUAL CENTRALERT (PM)

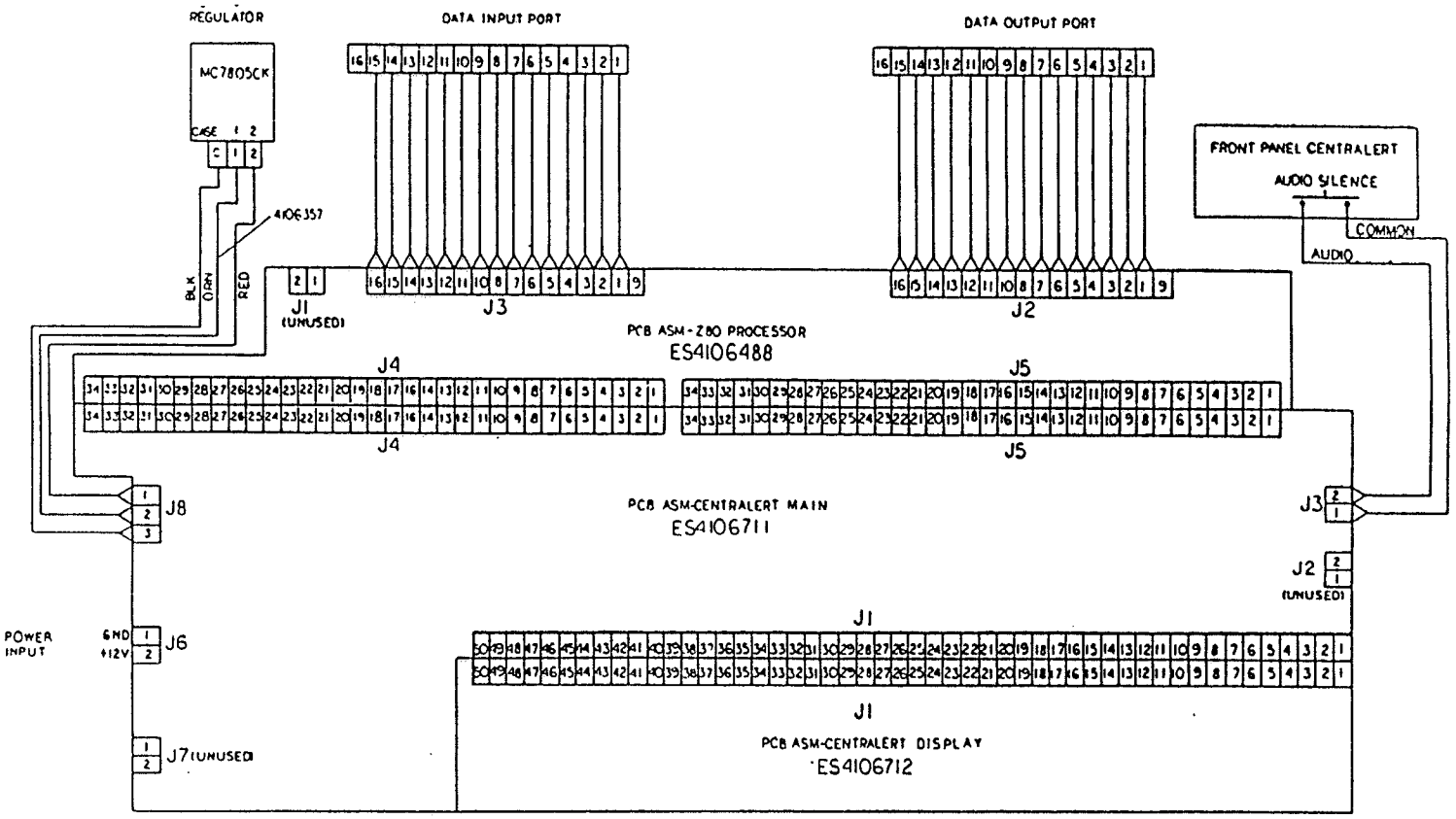
CENTRALERT (PM)
WITH NARKOMED 2A INTERFACE



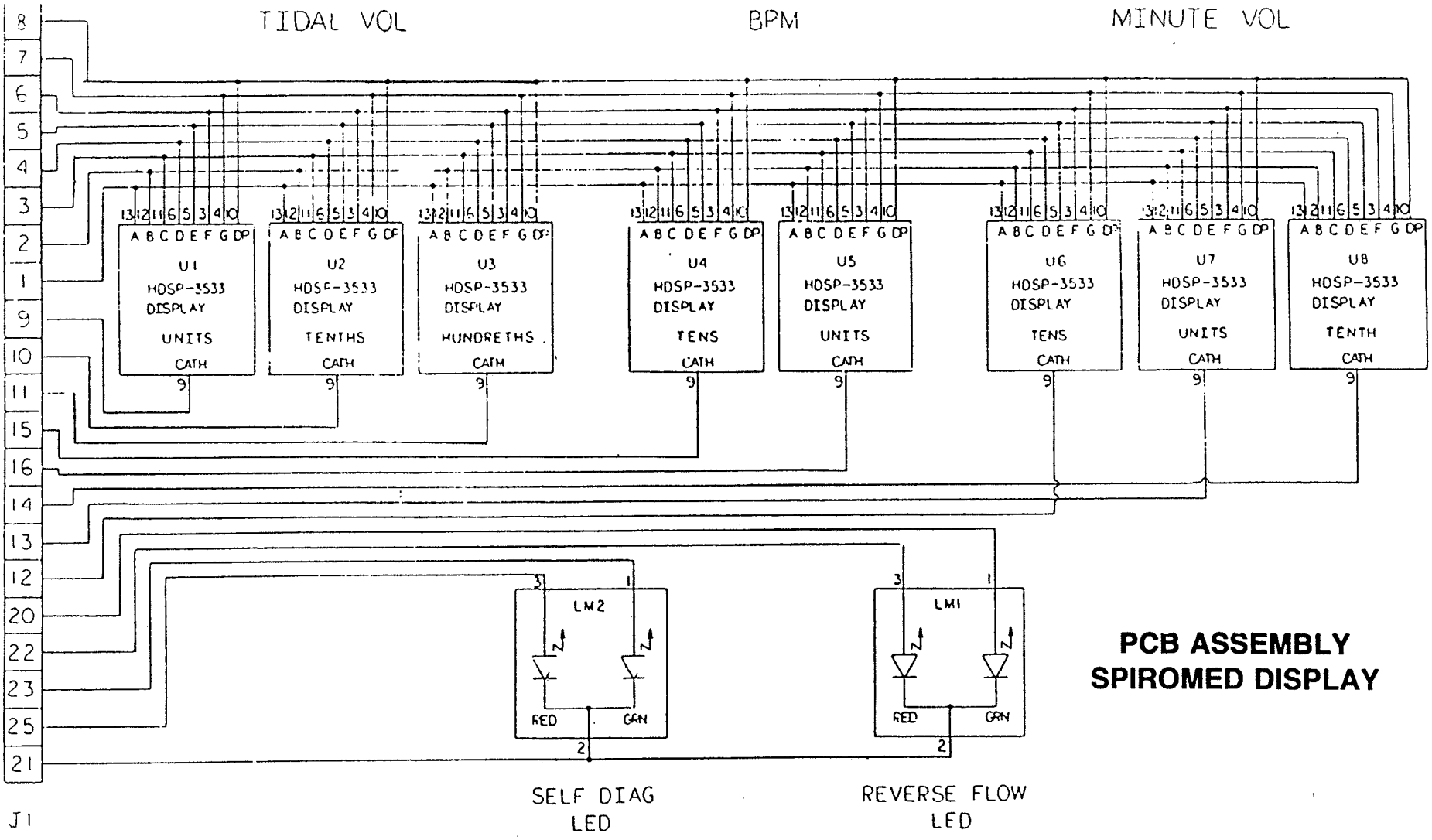
PCB ASSEMBLY
SPIROMED DISPLAY



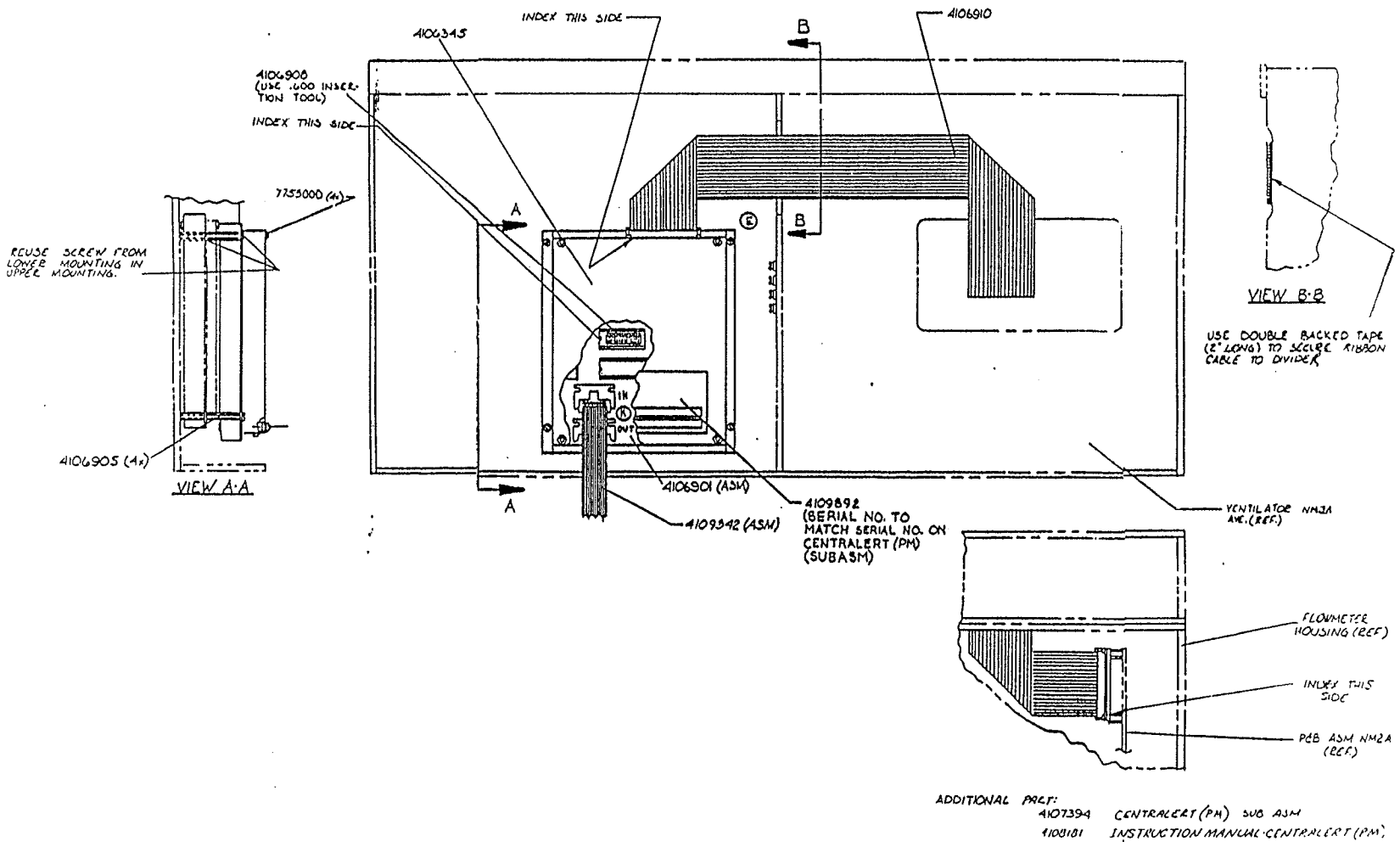
CENTRALERT (PM)



CENTRALERT (PM)



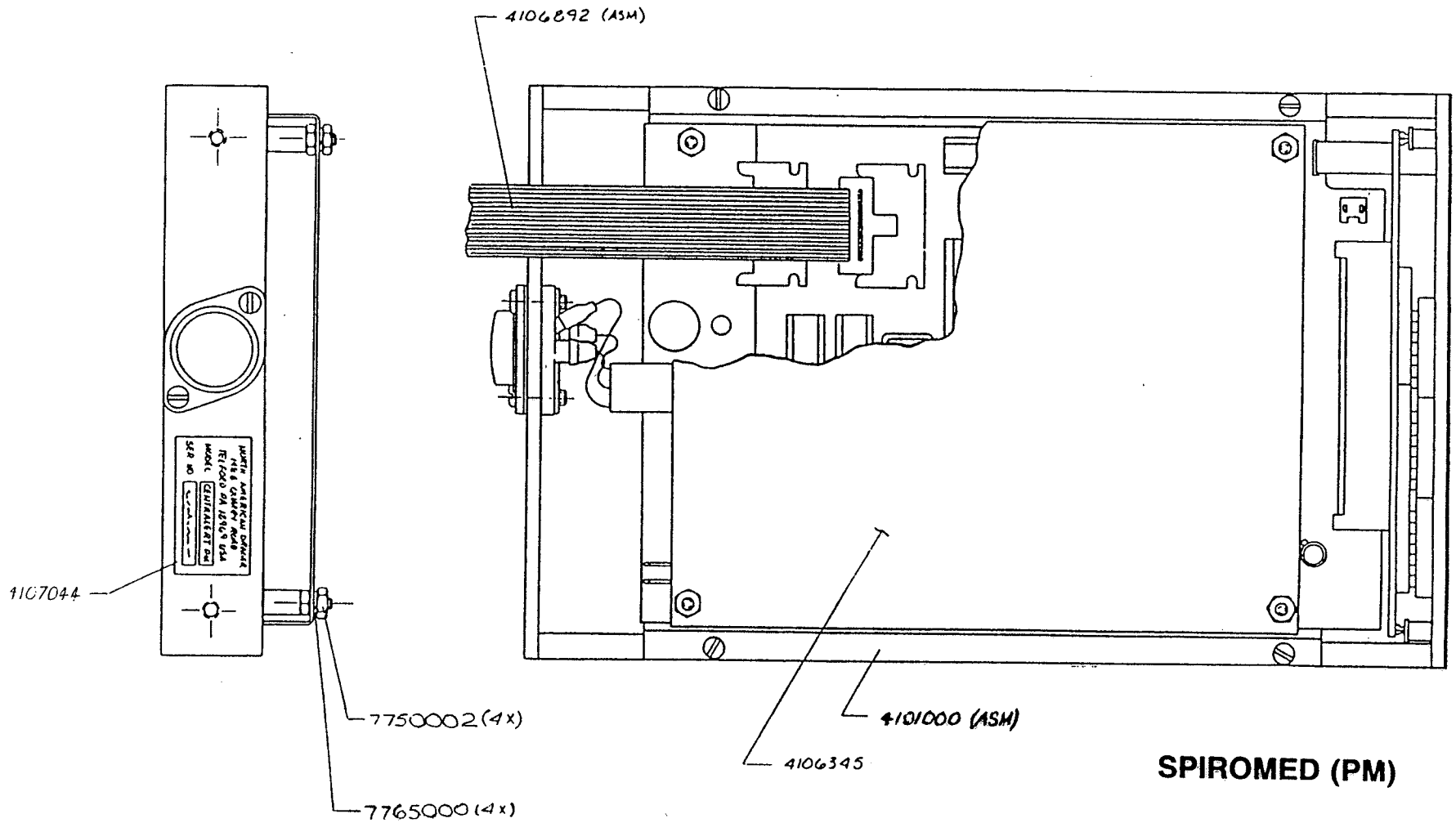
PCB ASSEMBLY
SPIROMED DISPLAY



ADDITIONAL PART:

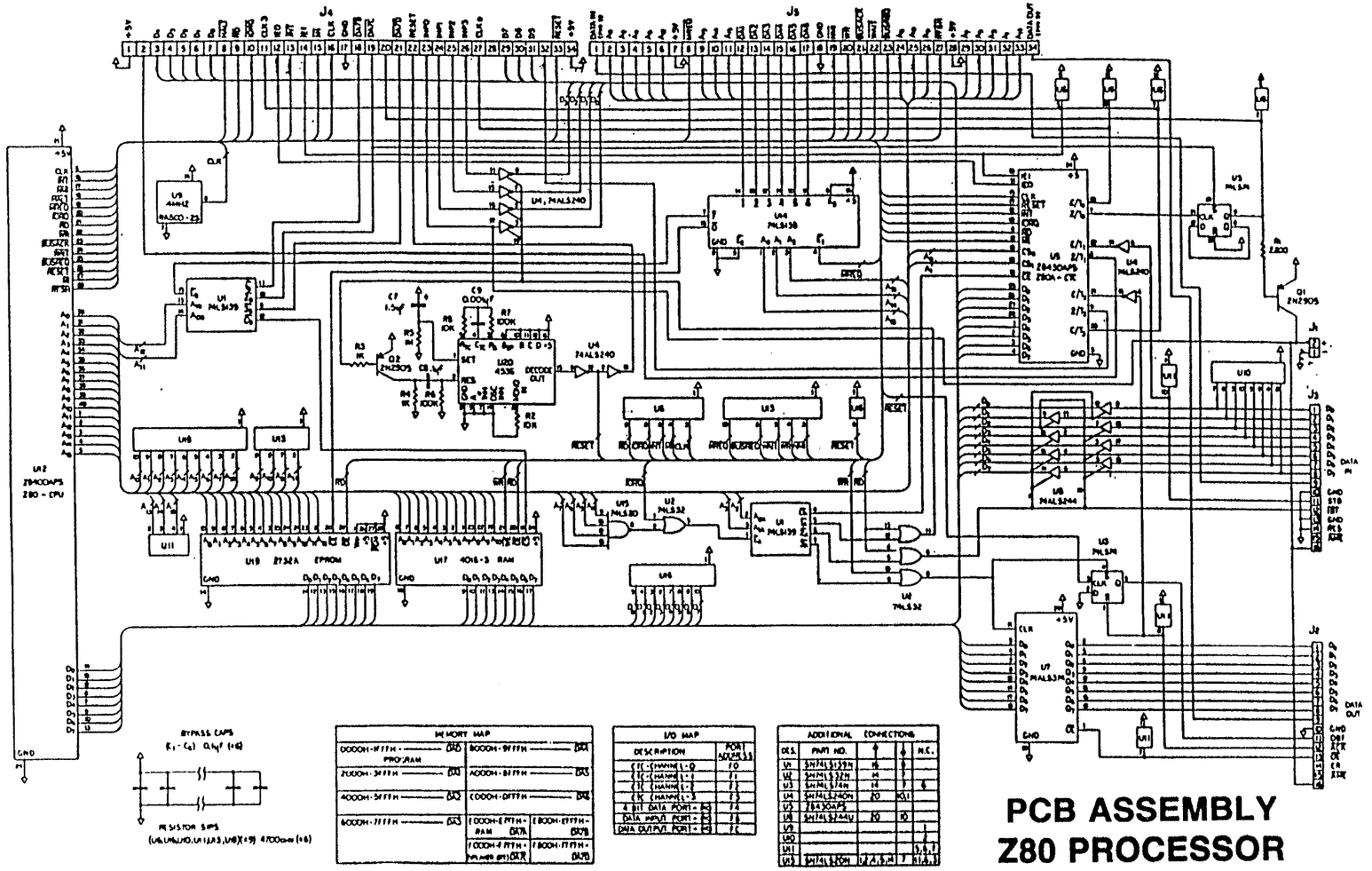
4107394	CENTRALERT (PM) SUB ASM
4108181	INSTRUCTION MANUAL CENTRALERT (PM)

CENTRALERT (PM)
WITH NARKOMED 2A INTERFACE



SPIROMED (PM)

ADDITIONAL PART:
4106362 SENSOR ASM - SPIROMED

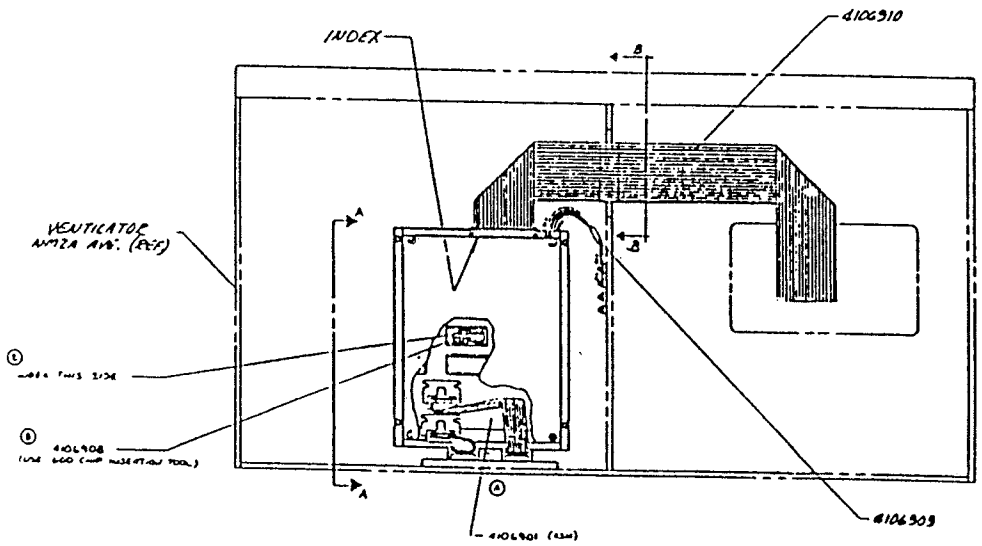


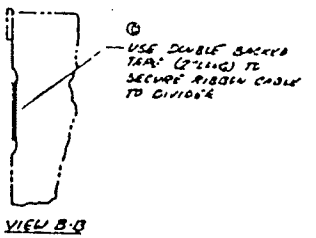
MEMORY MAP			
0000H-1FFFH — PROGRAM	D0	8000H-9FFFH	D0
2000H-3FFFH	D1	A000H-BFFFH	D1
4000H-5FFFH	D2	C000H-DFFFH	D2
6000H-7FFFH	D3	E000H-E7FFH - RAM DATA	E800H-EFFFH (D3)
		E000H-E7FFH - RAM ADDR	F800H-FFFFH (D0)

I/O MAP	
DESCRIPTION	PORT ADDRESS
CTC (CHANNEL 0)	F0
CTC (CHANNEL 1)	F1
CTC (CHANNEL 2)	F2
CTC (CHANNEL 3)	F3
8 BIT DATA PORT - A	F4
DATA INPUT PORT - B	F5
DATA OUTPUT PORT - B	F6

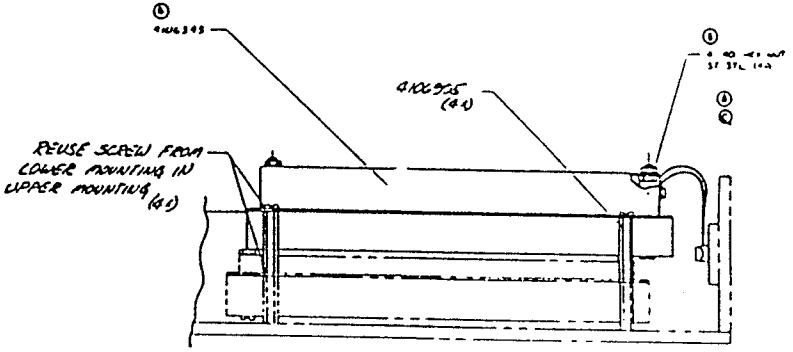
ADDITIONAL CONNECTIONS				
DES.	PART NO.			N.C.
U1	SN74LS139N	16	8	
U2	SN74LS32N	14	7	
U3	SN74LS74N	14	7	6
U4	SN74LS240N	20	10,1	
U5	Z84300APS			
U6	SN74LS244V	20	10	
U7				
U8				
U11				9,8,1
U13	SN74LS30N	14	7	11,4,3

PCB ASSEMBLY
Z80 PROCESSOR

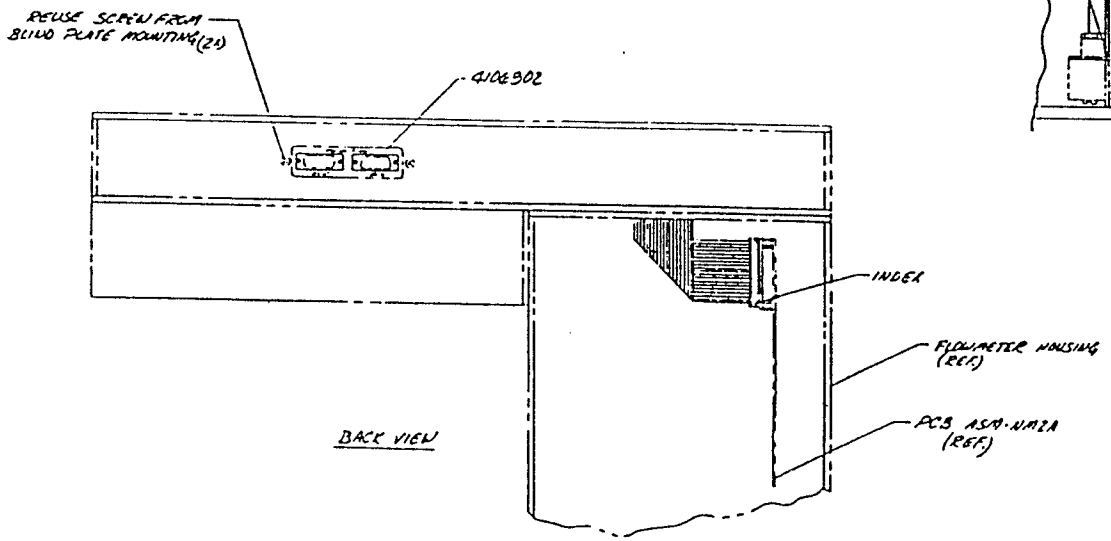




VIEW B-B

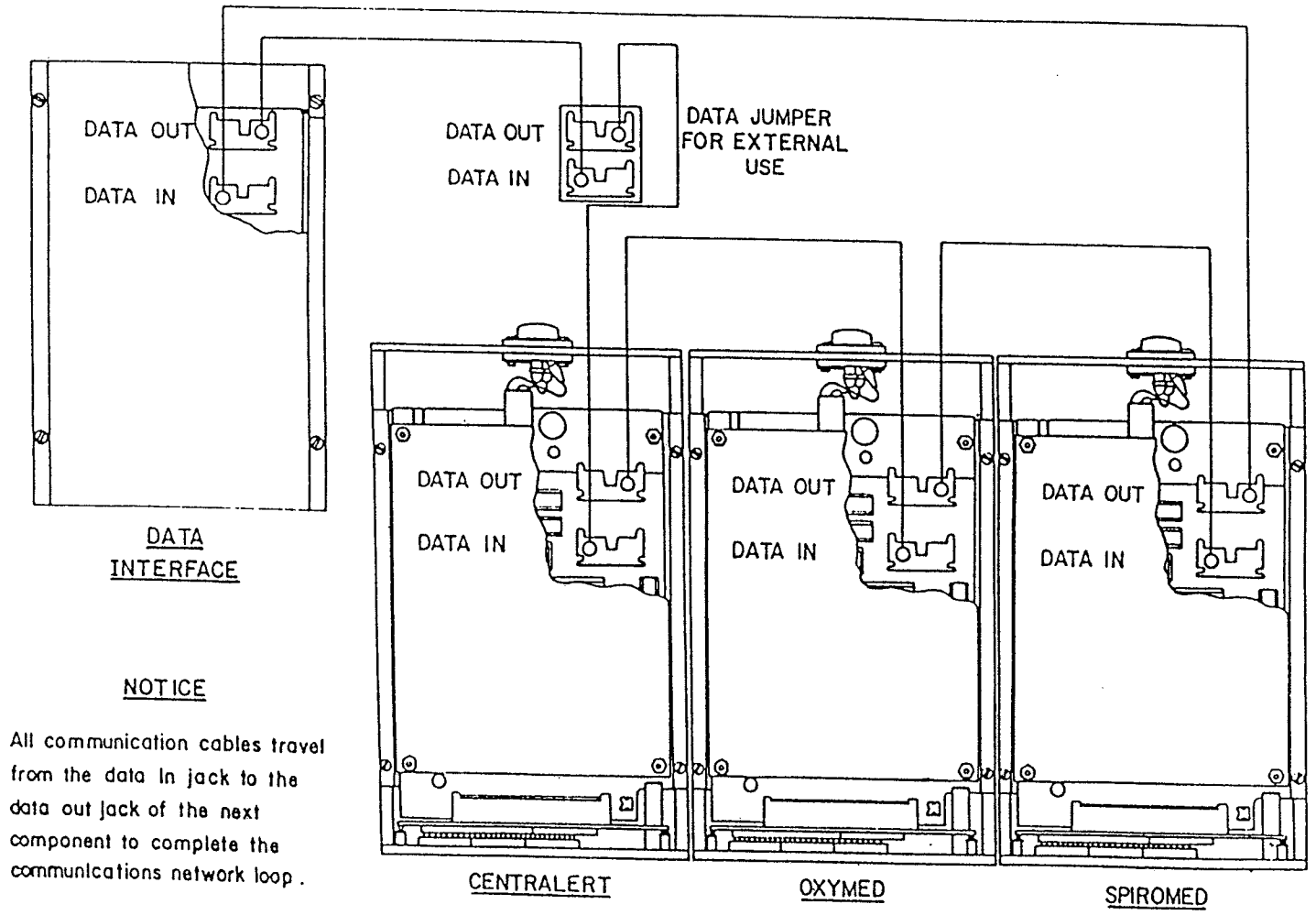


VIEW A-A
(ROTATED 90°)
SCALE 1:1



BACK VIEW

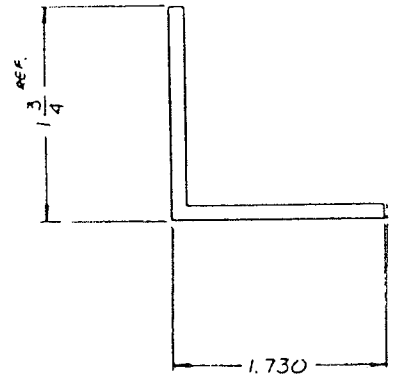
NARKOMED 2A
DATA INTERFACE

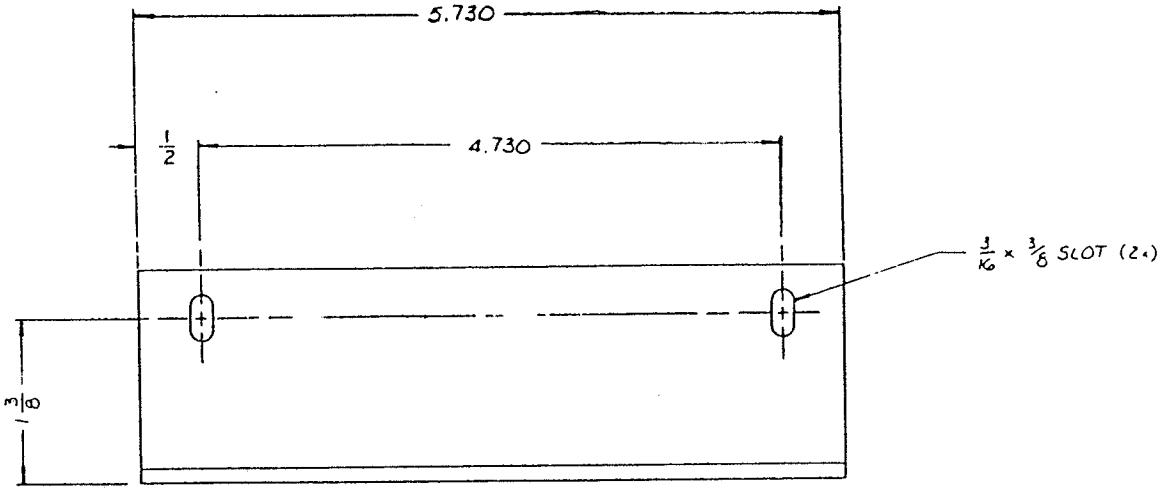


NOTICE

All communication cables travel from the data In jack to the data out jack of the next component to complete the communications network loop.

PANEL MOUNT COMMUNICATIONS NETWORK LOOP





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OVEN BAKED

ANGLE-MONITOR BLANK

Tab 5

NAD CONVERSION KITS FOR FIELD INSTALLATIONS

Modification of NAD Anesthesia Equipment

Modifications of NAD anesthesia equipment shall only be performed by service representatives of NAD Authorized Technical Service Centers.

Only modifications listed in this section of the NAD Service Manual are authorized to be performed on NAD anesthesia equipment.

NAD, Inc. and its insurance carrier will disclaim liability for equipment that incorporates unauthorized modifications. As a result of this disclaimer the organization who performed such unauthorized modification will bear full responsitility if the modified equipment should become involved in an accident adversely affecting patient safety.

In addition to the loss of liability coverage, unauthorized equipment modification may result in the organization performing an unauthorized equipment modification falling into the category of "manufacturer" turer" under the FDA regulations. That would require to register this organization with the FDA as a manufacturer and institute all of the controls and procedures that are essential with registration. The registration requirement is part of section 807.20 of Part 21 of the U.S. Code of Federal Regulation.

In the interest of the patient, the customer, the NAD Authorized Technical Service Centers as well as North American Drager, Conversion Kits for equipment modifications will only be made available to NAD Authorized Technical Service Centers.

It may be necessary to contact the NAD Technical Service Department for details on the installation of various conversion kits due to the customization of some anesthesia equipment.

1.0. Vapor Exclusion Systems and Selector Valves

1.1. Conversion from vapor selector valve or 2-vapor exclusion system to 3-vapor exclusion system - Narkomed 2 or AM III with standard size ventilator chassis

1.2. Conversion from vapor selector valve to 3-vapor exclusion system - Narkomed Standard

1.3. Update of vapor selector valve

1.4. 2-Vapor exclusion systems

2.0. Air Gas Circuits

2.1. Add complete air gas circuit with N_2O/Air switch to Narkomed 2A

2.2. Add complete air gas circuit without N_2O/Air switch to Narkomed 2

2.3. Add air DISS to Narkomed 2 and 2A with air yoke system

2.4. Add air yoke to Narkomed 2 or 2A with air DISS system

2.5. Add complete air gas circuit to Narkomed Standard

2.6. Add air DISS to Narkomed Standard with air yoke system

2.7. Add air yoke to Narkomed Standard with air DISS system

3.0. Electronic Anesthesia Ventilators

3.1. Convert pneumatic ventilator to electronic ventilator on Narkomed 2 with standard size ventilator chassis

3.2. Convert pneumatic ventilator to electronic ventilator on Narkomed Standard

4.0. Flowmeter Lights

4.1. Installation of 2-gas flowmeter lights on Narkomed 2 with 2 (two) gases

4.2. Installation of 3-gas flowmeter lights on Narkomed 2 with 3 (three) gases

4.3. Installation of 2-gas flowmeter lights on Narkomed 2A with 2 (two) gases

4.4. Installation of 3-gas flowmeter lights on Narkomed 2A with 3 (three) gases

5.0. Addition of Various Gas Circuits

5.1. Addition of 1-gas circuit to Narkomed 2 with 2 (two) or 3 (three) gases

5.2. Addition of 2-gas circuits to Narkomed 2 with 2 (two) gases

5.3. Addition of 1-gas circuit to Narkomed 2A with 2 (two) or 3 (three) gases

5.4 Addition of 2-gas circuits to Narkomed 2A with 2 (two) gases

6.0. O.R.M. and O.R.M.c.

6.1. Installation of O.R.M. to Narkomed Standard

6.2. Installation of O.R.M.c. to Narkomed Standard

6.3. Installation of O.R.M. to Narkomed Compact

6.4. Convert O.R.M. to O.R.M.c. on Narkomed 2 or 2A

6.5. Convert O.R.M.c. to O.R.M. on Narkomed 2 or 2A

7.0. Panel Mounted Monitors to NM2A

7.1. Complete Panel Mount Monitor Kit

7.2. Panel Mount Kit without Centralert

7.3. Panel Mount Kit without Spiromed

7.4. Panel Mount Kit without Oxymed

7.5. Accessories

8.0. Miscellaneous

8.1. Installation of low flow oxygen system to Narkomed 2 or 2A

8.2. Installation and interface DPM-S to ventilator

8.3. Installation of tidal volume lock bar to ventilator volume control

8.4. Relocation of ventilator relief valve from manual/automatic selector valve to ascending bellows dome

8.5. Installation of DISS patient suction system to Narkomed 2 or 2A

1.0. Vapor Exclusion Systems and Selector Valves

1.1. S4105417 A - 2-vapor exclusion system for Narkomed 2 (see procedures 3.6.0.0., 3.7.0.0., 7.1.0.0. and drawing SKOB010, SKOB011)
S000087 A - 3-vapor exclusion system for AM III (see procedures 3.6.0.0., 3.7.0.0 , 7 1.0.0. and drawings SKOB010, SKOB011)

1.1.1. 3-VAPORIZER EXCLUSION SYSTEM FOR AM III & NARKOMED 2 4105417 - COMPLETE KIT

PART	PART DESCRIPTION
4102723 P	Unions
4102765 P	Coupling
8807003 P	1/4" diameter copper tubing
SKOB011	Drill guide template
SKOB010	Mounting bracket (One per NAD Distributor)

1.1.2. 3-VAPORIZER EXCLUSION SYSTEM FOR NARKOMED STANDARD

The Narkomed Triple Vaporizer Conversion Kits are used for in-the-field upgrading of Narkomed machines to a 3-vaporizer system. Which conversion kit is used depends on the configuration of the Narkomed in question. The conversion kits should be selected according to the following schedule.

PART	PART DESCRIPTION
4105573 A	Old style vapor, no shelf or NAD/AV
4105570 A	Old style vapor with shelf or NAD/AV
4105573 A	Old style vapors, vapor selector valve, no shelf or NAD/AV
4105571 A	Old style vapors, vapor selector valve with shelf or NAD/AV
4105572 A	Vapor 19, no shelf or NAD/AV
4105570 A	Vapor 19 with shelf or NAD/AV
4105573 A	Vapors 19, vapor selector valve, no shelf or NAD/AV
4105571 A	Vapors 19, vapor selector valve with shelf or NAD/AV
4105570 A	Vapors 19 and 2-way exclusion system with vapor hoses connected to vapor selector valve location
4105570 A	Vapors 19 and 2-way exclusion system with vapor hoses connected to back of machine
4105574 A	Vapors 19 and 2-way exclusion system and chrome plated piping instead of vapor hoses

NOTE: Above system applies if competitor's vaporizers are currently used. However, competetitor's vaporizers must be replaced with vapors 19 or 19.1.

1.2. Vapor Exclusion Systems and Selector Valves

S4105572 A - 1-vapor without shelf or NAD/AV

S4105570 A - 1-vapor with shelf or NAD/AV

S4105573 A - 2-vapors, vapor selector valve, without shelf or NAD/AV

S4105571 A - 2-vapors, vapor selector valve, with shelf or NAD/AV

S4105572 A - 1-vapor 19 without shelf or NAD/AV

S4105570 A - 1-vapor 19 with shelf or NAD/AV

S4105573 A - 2-vapors 19, vapor selector valve without shelf or NAD/AV

S4105571 A - 2-vapor 19, vapor selector valve with shelf or NAD/AV

S4105570 A - 2-vapor 19 with 2-vapor exclusion system including vapor hoses connected to vapor selector valve location

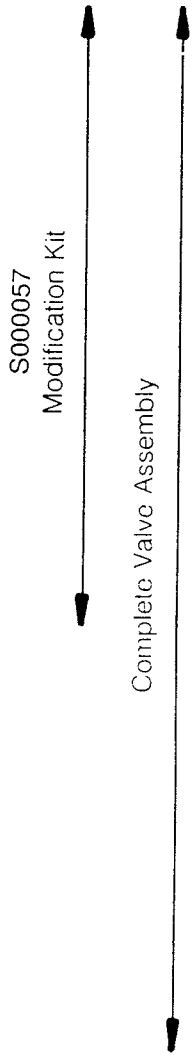
S4105570 A - 2-vapors 19 with 2-vapor exclusion system including vapor hoses connected to back of machine

S4105574 A - 2-vapors 19 with 2-vapor exclusion system including chromed plated piping

NOTE:
Vapors 19.1 may have to be sent to the NAD Technical Service Department for conversion vapor selector valve to exclusion system. If competitor's vaporizers are currently installed, vapors 19 or 19.1 must be installed in conjunction with NAD exclusion systems

1.3. Vapor Exclusion Systems and Selector Valves

PART	PART DESCRIPTION	QTY.
S1100507 A	Vapor selector valve	1
S1100525 P	Selector valve decal	1
S1101422 F	Spindle axle	1
S1101611 P	Spring	1
S1101406 P	Disc (rear)	1
S1101407 P	Disc (front)	1
S1101405 F	Arm	1
S1101419 P	Arrow sign	1
4101848 P	Ball	1
S4102357 M	Stem	1
S1101410 M	Screw	1
7775002 P	1/8 x 1/2" long roll pin	1
7775001 P	3/32 x 1/2" long roll pin	1
7711000 P	0 x 3/16 round head drive screw	2
S1101418 P	Valve body	1
S1101487 P	Vapor inlet connector	2
S1101488 P	Vapor outlet connector	2
S1101490 P	Valve base	1
1101502 F	Valve axle spring	2
7775002 P	1/8 x 1/2" long roll pin	2
7701025 P	10- x 1/2" long socket head cap screw	2
7701037 P	1/4-20 x 1" long socket head cap screw	2
7711000 P	0 x 3/16 round head drive screw	4



1.4. Vapor Exclusion Systems and Selector Valves

2-Vapor Exclusion System

1.4.1. 2-VAPORIZER EXCLUSION SYSTEM FOR AM III & NARKOMED 2

PART	PART DESCRIPTION	QTY.
4104346 F	Block	2
4104349 F	Pivot arm	1
4104342 F	Bushing	2
4104343 P	Shaft	1
4104344 M	Washer	2
4103512 P	Retainer clip	2
4104345 M	Pin	2
4103269 F	Vapor mount	2
4103357 P	Front cover	1
4102723 P	Male connectors	4
4102765 P	Coupling	1
8807003 P	1/4" diameter copper tubing	3 ft.
7704002 P	6/32-3/8" long cup point set screw	1
7701018 P	8/32 x 1" long socket head cap screw	4
7701037 P	1/4-20 x 1" long socket head cap screw	4
MISC	1/4 lockwasher	4

1.4.2. 2-VAPORIZER EXCLUSION SYSTEM FOR NARKOMED STANDARD

PART	PART DESCRIPTION	QTY.
4104407 F	Block solder assembly	1
4104405 F	Interlock block	2
4104346 F	Block	2
4104342 F	Bushing	2
4104344 M	Washer	2
4104343 M	Shaft	2
4104345 M	Pin	2
4104349 F	Pivot arm	1
1101487 F	Vapor terminal - IN	1
1101488 F	Vapor terminal - OUT	1
4104451 A	Hose assembly - IN	1
4104452 A	Hose assembly - OUT	1
1100364 F	Vapor inlet connector	1
1100365 F	Vapor outlet connector	1

2-VAPORIZER EXCLUSION SYSTEM FOR NARKOMED STANDARD

PART	PART DESCRIPTION	QTY.
4103512 P	Retaining clip	2
7704009 P	10-32 x 3/8" long set screw	1
7752002 P	5/8-18 thin hex nut	2
7701018 P	8-32 x 1" long socket head cap screw	12
7701035 P	1/4-20 x 5/8" long socket head cap screw	2
MISC	1/4 lockwasher	2

2.0. Air Gas Circuits

2.1. S000082 A - Complete air gasa circuit with selector switch for Narkomed 2A only

2.2. S000072 A - Complete air gas circuit without selector switch for Narkomed 2

2.3. S000073 A - Addition of DISS to air gas circuit with existing yoke for Narkomed 2 or 2A

2.4. S000074 A - Addition of yoke to air gas circuit with existing DISS for Narkomed 2 or 2A

For installations 2.1. to 2.4. see drawing SKOB012

2.5. S000068 A - Complete air gas circuit for Narkomed Standard

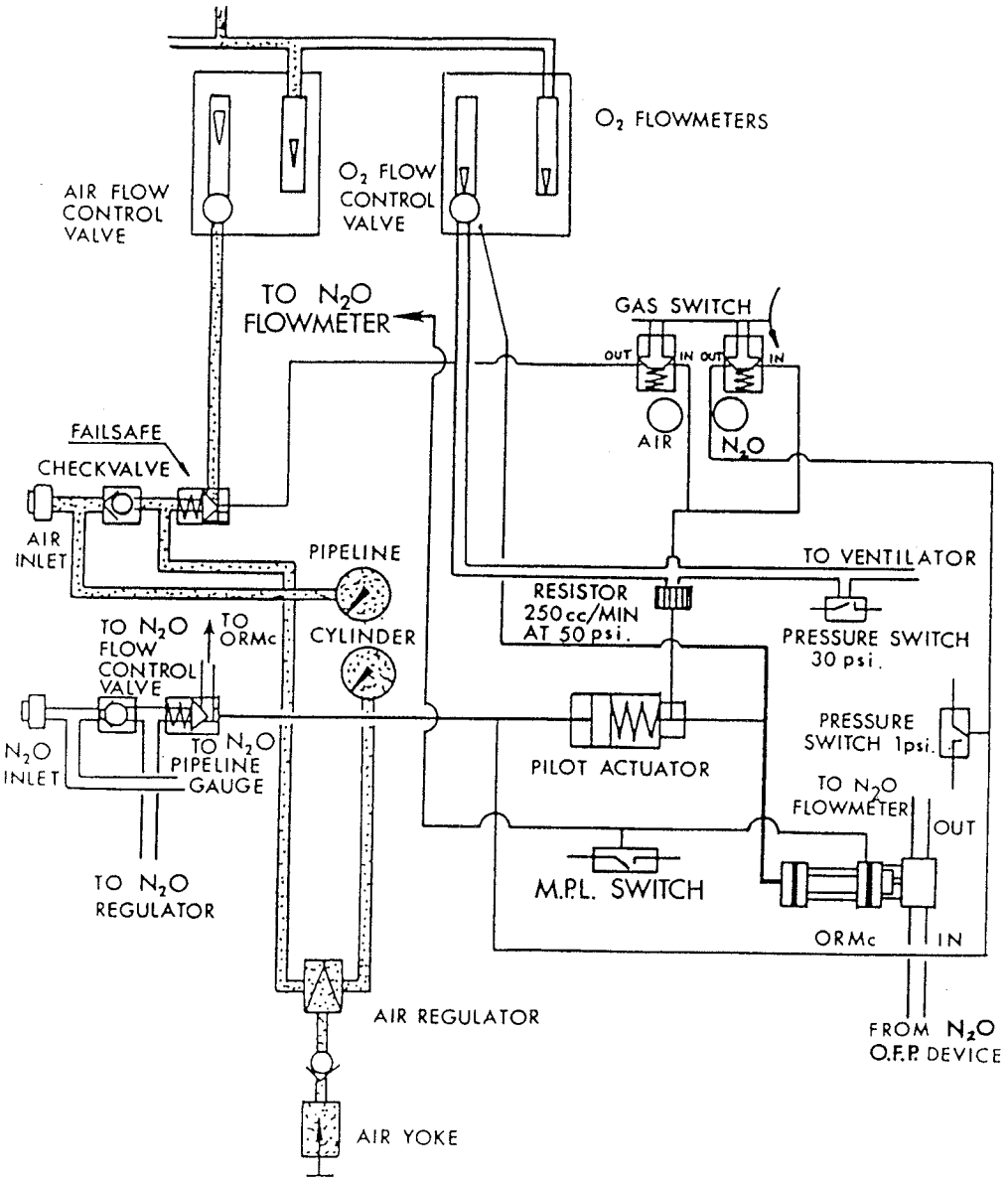
2.6. S000070 A - Addition of DISS to air gas circuit with existing yoke for Narkomed Standard

2.7. S000071 A - Addition of yoke to air gas circuit with existing DISS for Narkomed Standard

For installations 2.5. to 2.7. see drawing SKOB022

2.1.

AIR ATTACHMENT, DISS/YOKE



2.2. COMPLETE AIR CIRCUIT (WITHOUT AIR/N_2O SWITCH) - NARKOMED 2

REF.	PART DESCRIPTION	QTY.
1	Air channel assembly	1
2	Air gauge channel	1
3	Air gauge 4000 psi	1
4	Air gauge 100 psi	1
5	Female connector (for 4000 psi gauge)	1
6	Female connector (for 100 psi gauge)	1
7	O.F.P. Device	1
8	Female DISS	1
	Flowmeter shield	1
9	Male elbow	2
10	4-way fitting	1
	Instruction decal	1
11	3-way fitting	2
12	Check valve	1
13	Male connector	2
14	Tee	1
15	Oxygen inlet block with 3/4-16 nut	1
16	Air DISS inlet	1
17	Gas sign air	1
18	Air regulator assembly	1
19	Air yoke assembly	1
	1/4" diameter copper tubing	6 ft.
	3/16" diameter copper tubing	4 ft.
	1/4-28 x 1/4" long socket screw (air channel)	2
	1/4 lockwasher (air channel)	2
	2/56 x 1/4" long flat head screw (flowshield)	2
	8/32 x 1/2" long socket screw (regulator bracket)	2
	NOTE: 5/16-24 x 1 3/4" long socket screws must be included if air yoke is installed next to nitrous oxide yoke on right side of machine	2
	NOTE:	
20	5/16-24 x 1 3/4" long socket screw yoke spacer must be included when air yoke is installed above battery compartment See SKOB012	2

COMPLETE AIR CIRCUIT (WITHOUT AIR/N_2O SWITCH)-NARKOMED 2

NOTE:
The following parts must be used when air DISS circuit is installed without yoke assembly:

Gauge plug, see SKOB012	1
Support plate, see SKOB012	1
Male elbow (9) in lieu of running tee (14)	1

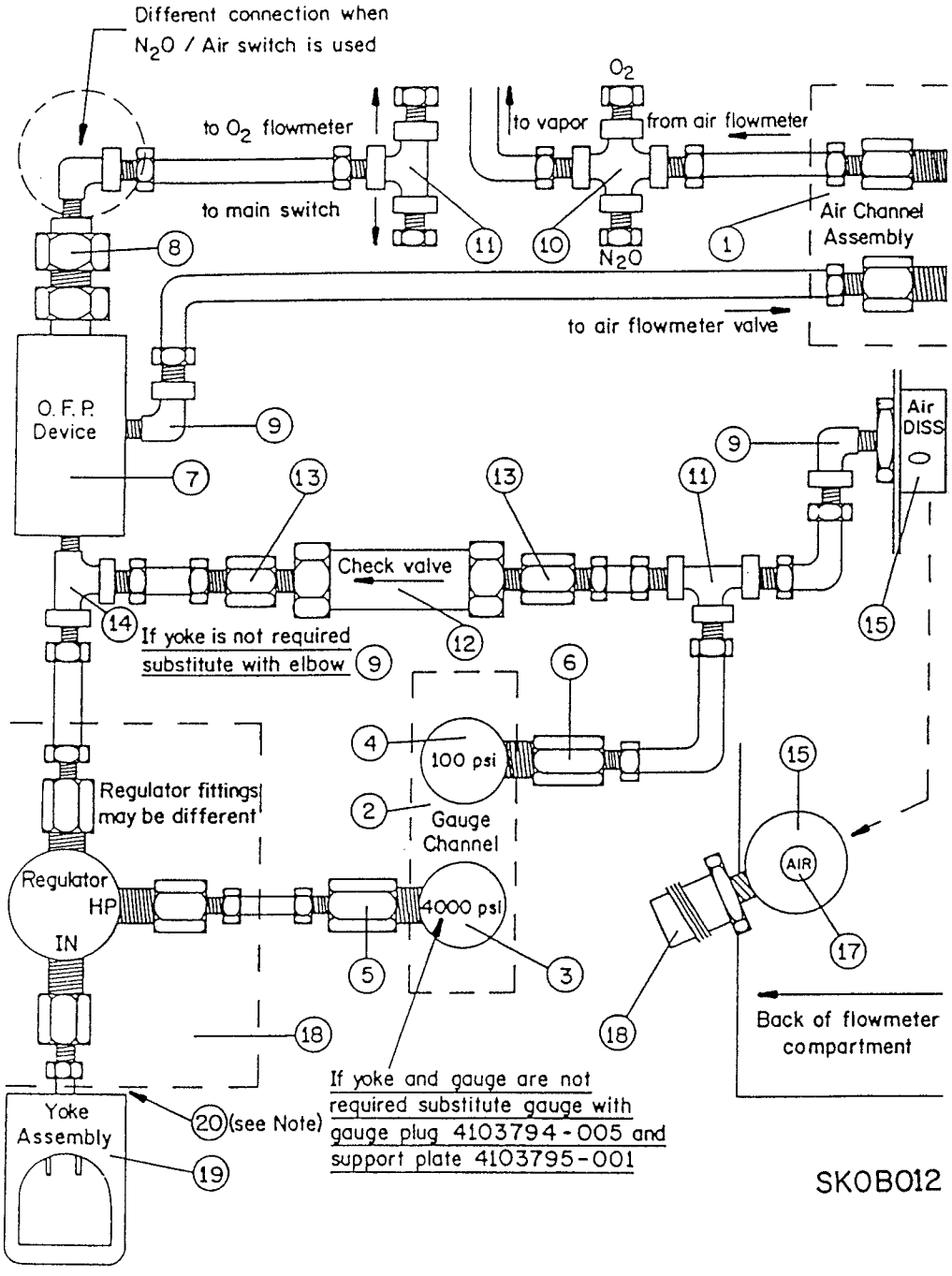
2.3. PARTS TO ADD AIR DISS TO AIR YOKE - NARKOMED 2

REF.	PART DESCRIPTION	QTY.
15	Oxygen inlet block with 3/4-16 nut	1
16	Air DISS inlet	1
17	Gas sign air	1
14	Tee	1
13	Male connectors	2
12	Check valve	1
11	3-way fitting	1
4	Air gauge 100 psi	1
6	Female connector	1
9	Male elbow	1
	1/4" diameter copper tubing	3 ft.

2.4. PARTS TO ADD AIR YOKE TO AIR DISS - NARKOMED 2

REF.	PART DESCRIPTION	QTY.
18	Air regulator assembly	1
19	Air yoke assembly	1
3	Air gauge 4000 psi	1
5	Female connector	1
14	Tee	1
	1/4" diameter copper tubing	3 ft.
	3/16" diameter copper tubing	4 ft.
	8/32 x 1/2" long socket screws (regulator bracket)	2
	NOTE: 5/16-24 x 1 3/4" long socket screws must be included if air yoke is installed next to nitrous oxide yoke on right side of machine	2
	NOTE:	
20	5/16-24 x 1 3/4" long socket screws	2
	yoke spacer must be included when air yoke is installed above battery compartment, see SKOB012	1

INSTALLATION OF AIR CIRCUIT-NARKOMED 2 WITHOUT N_2O/AIR SWITCH



2.5. COMPLETE AIR GAS CIRCUIT-NARKOMED STANDARD

REF.	PART DESCRIPTION	QTY.
1	Flowmeter assembly	1
	Air label	1
	Air sign	1
	Air flowmeter tube	1
	3-tube shield assembly	1
	Blind plate	1
2	Air tower assembly	1
	Flowmeter spacer	1
3	3-way fittings	2
	Coupling	1
	Back cover	1
15	Air gauge 4000 psi	1
16	Female Connector	1
	Yoke Spacer	1
17	Air yoke assembly	1
18	Air regulator assembly	1
10	Running Tee (between check valve and O.F.P.D.)	1
11	Male connector	1
9	Close nipple	1
	1/4" diameter copper tubing	3 ft
	3/16" diameter copper tubing	3 ft
4	1/4-20 x 1/2" long socket head cap screws	2
	10-32 x 1/2" long round head cap screw	1
	10-32 x 2 1/2" long round head cap screw	1
	1/4 flat washer	2

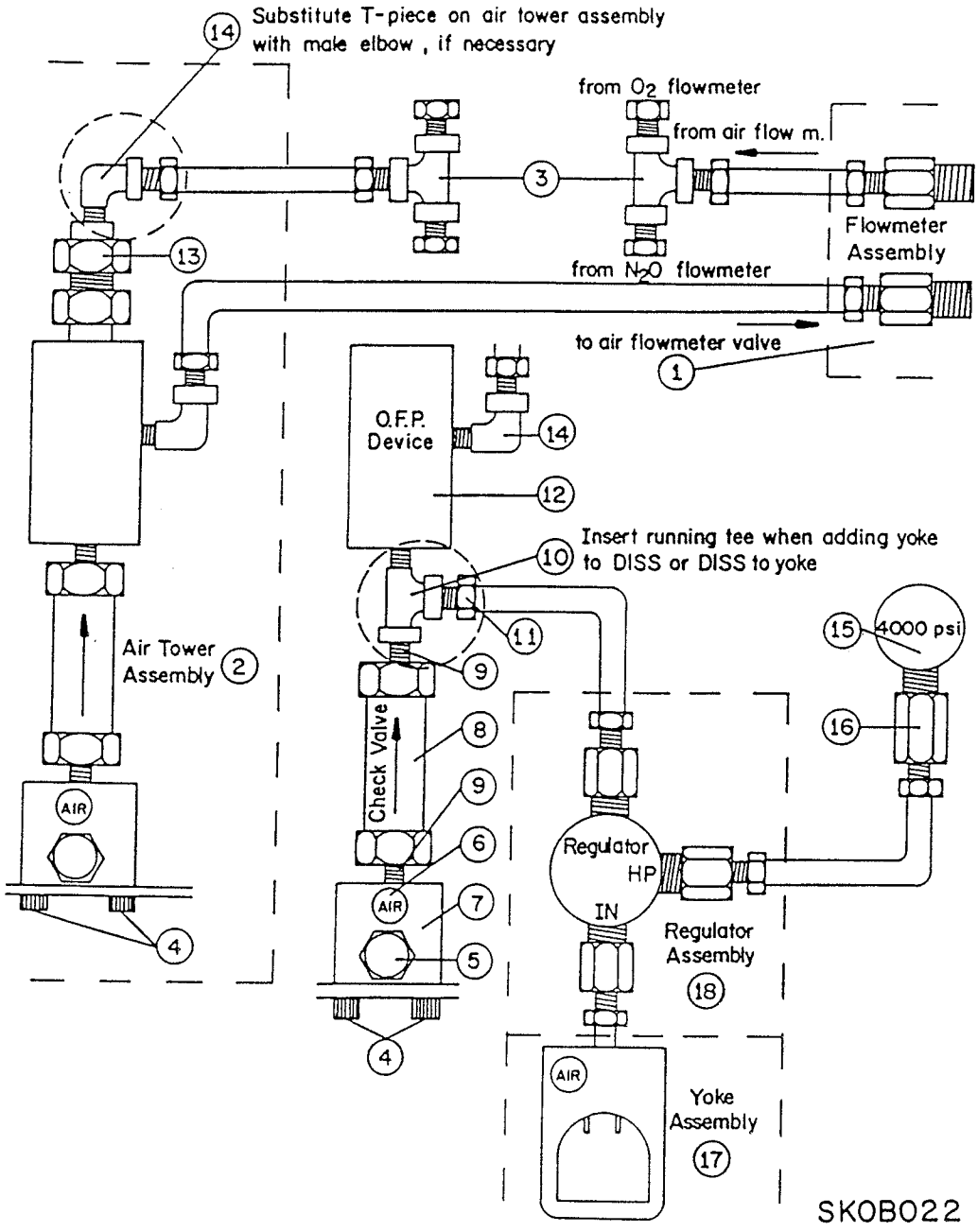
2.6. PARTS TO ADD AIR DISS TO AIR YOKE - NARKOMED STANDARD

REF.	PART DESCRIPTION	QTY.
5	Air DISS inlet	1
6	Air gas sign	1
7	Inlet block	1
8	Check valve	1
	Back cover	1
9	Close nipple	2
10	Running Tee (between check valve and O.F.P.D.)	1
11	Male connector	1
	1/4" diameter copper tubing	2 ft
4	1/4-20 x 1/2" long socket head cap screw	2

2.7. PARTS TO ADD AIR YOKE TO AIR DISS - NARKOMED STANDARD

REF.	PART DESCRIPTION	QTY.
15	Air gauge 4000 psi	1
16	Female connector	1
	Yoke spacer	1
17	Air yoke assembly	1
18	Air regulator assembly	1
10	Running Tee (between check valve and O.F.P.D.)	1
11	Male connector	1
9	Close nipple	1
	1/4" diameter copper tubing	2 ft.
	3/16" diameter copper tubing	3 ft.

INSTALLATION OF AIR CIRCUIT-NARKOMED STANDARD



3.0. Electronic Anesthesia Ventilator

3.1. S4105482 A - Conversion of AV to AV-E for Narkomed 2 with standard ventilator chassis
See procedure 3.8.0.0. and drawings SKOB028, SKOB029

3.2. S4105483 A - Conversion of AV to AV-E for Narkomed Standard, see procedure 3.9.0.0. and drawing SKOB027

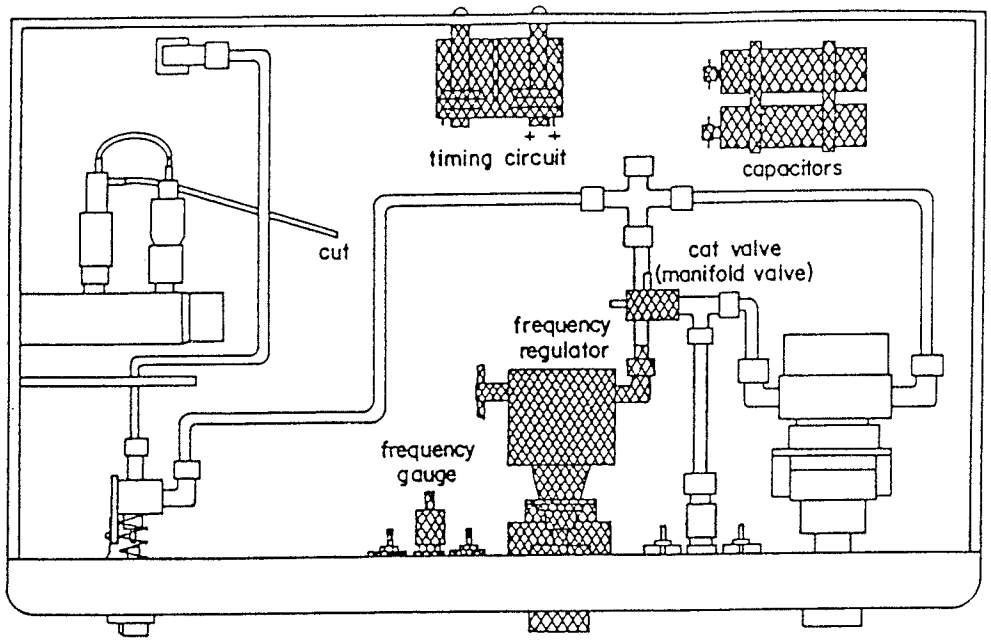


Figure I

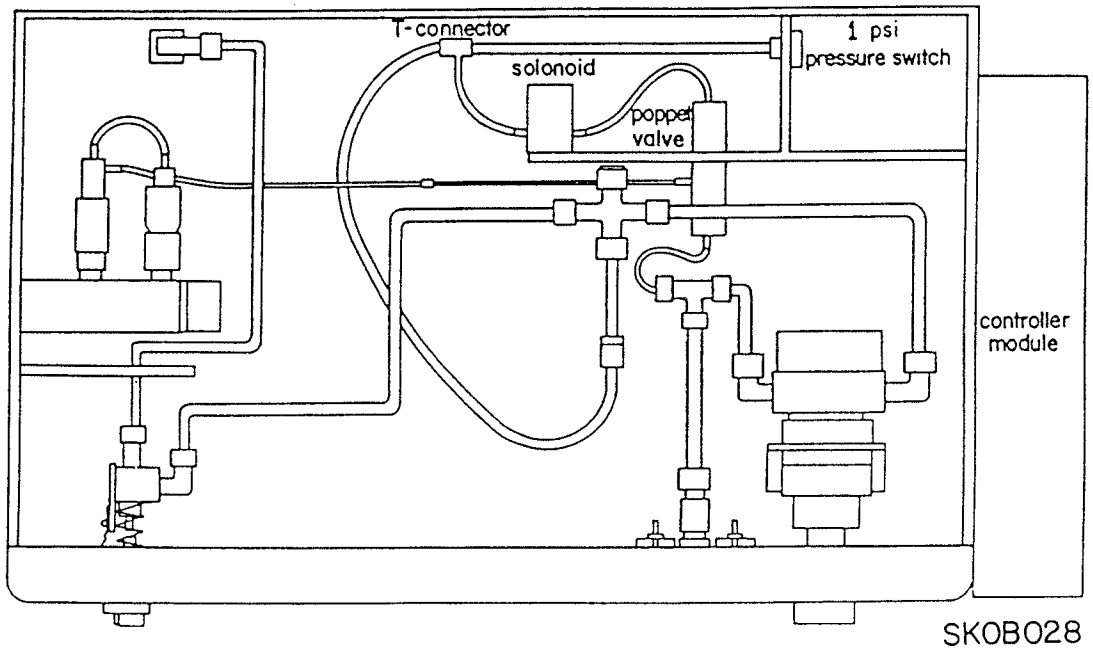


Figure II

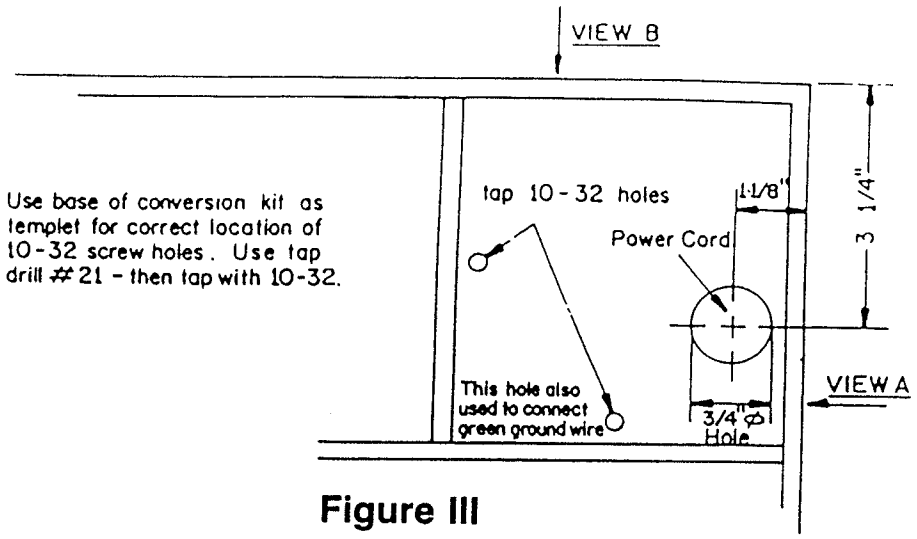
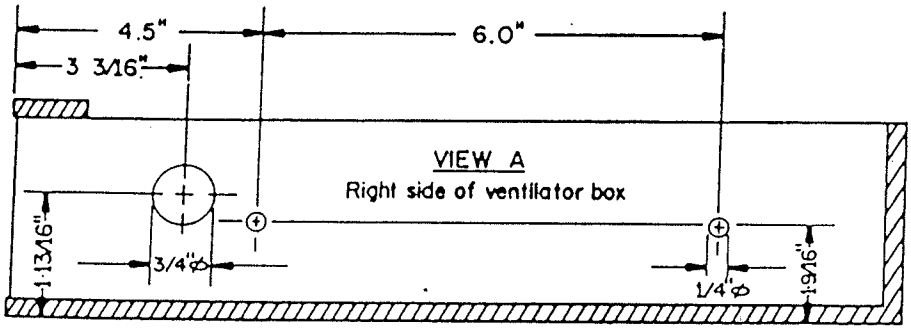
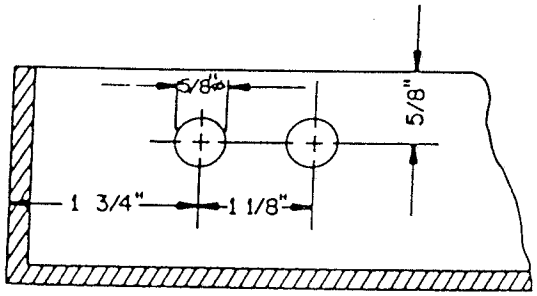


Figure III





VIEW B
Back of ventilator box

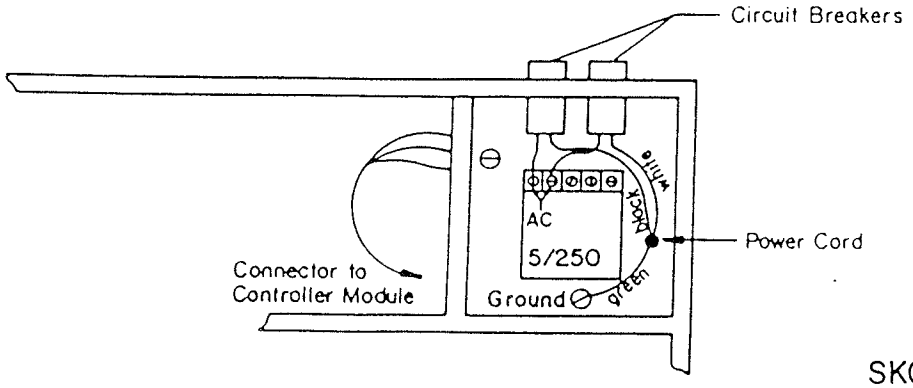
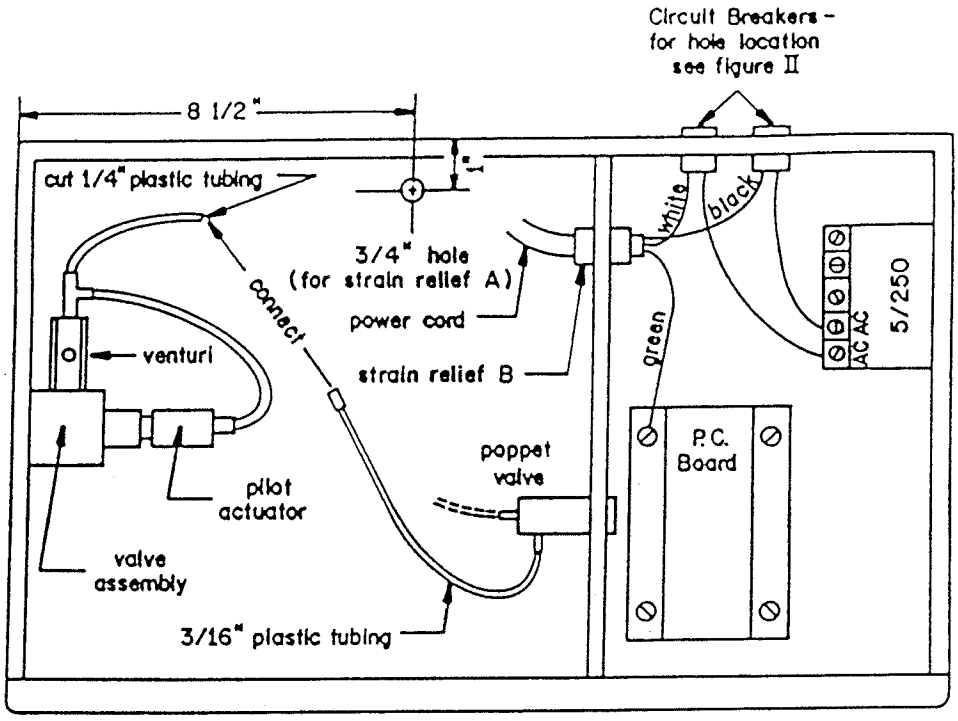


Figure IV



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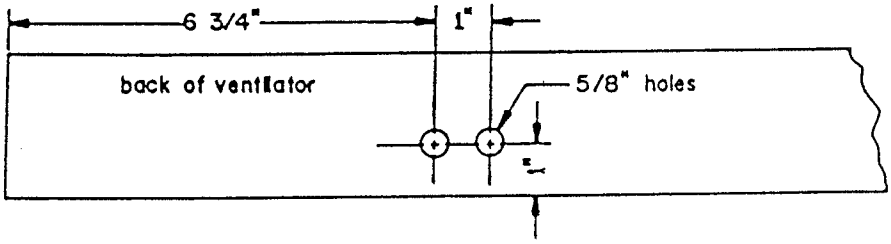
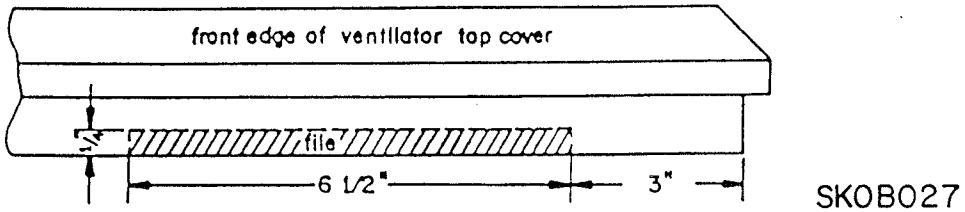


Figure II



SKOB027

Figure III

4.0. Flowmeter Lights

4.1. S000088 A - Narkomed 2, 2-gas with AV-E

4.2. S000089 A - Narkomed 2, 3-gas with AV-E

4.3. 4104740 A - Narkomed 2A, 2-gas

4.4. 4106150 A - Narkomed 2A, 3-gas

For installation of flowmeter light on Narkomed 2 or 2A with 4-gas, contact the NAD Technical Service Department

5.0. Addition of Various Gas Circuits

For installation of additional gas circuit other than air contact the NAD Technical Service Department

6.0. O.R.M. and O.R.M.c.

6.1. S000115 A - O.R.M. installation on Narkomed Standard

6.2. S000116 A - O.R.M.c. installation on Narkomed Standard, see procedure 3.10.10

6.3. S000117 A - O.R.M. installation on Narkomed Compact

6.4. S000118 A - Conversion of O.R.M. to O.R.M.c. on Narkomed 2 or 2A, see procedure 3.10.00

6.5. S000119 A - Conversion of O.R.M.c. to O.R.M. on Narkomed 2 or 2A

7.0. Panel Mounted Monitors

NOTE:
See procedure 5.13.0.0. for panel mounted monitor installations

7.1. S000101 A - Complete Panel Mount Monitor Kit

7.2. S000102 A - Panel Mount Kit without Centralert

7.3. S000103 A - Panel Mount Kit without Spiromed

7.4. S000104 A - Panel Mount Kit without Oxymed

7.5. Accessories
The following accessories must be ordered as required in addition to the panel mount kit

7.5.1. S000105 A - Oxymed Accessories

7.5.2. S000106 A - Descending Bellows Extension Kit

7.5.3. S000107 A - Second Shelf Conversion Kit

7.5.4. S000108 A - Spiromed Accessories

7.5.5. S000109 A - Panel Mount Conversion Kit w/ Oxymed Only

7.5.6. S000110 A - Panel Mount Conversion Kit w/ Spiromed Only

7.5.7. S000111 A - Panel Mount Conversion Kit w/ Centralert Only

7.5.8. S000112 A - Oxymed Chassis Only

7.5.9. S000113 A - Spiromed Chassis Only

7.5.10. S000114 A - Centralert Chassis Only

8.0. Miscellaneous

8.1. S000090 A - Low Flow Oxygen Kit (See Service Procedure 3.11.0.0.)

8.2. S000120 A - DPM-S Interface Kit

8.3. 4105620 A - Tidal Volume Lock Bar Assembly

8.4. S000121 A - Ventilator Relief Valve to Bellows Dome

8.5. S000122 A - Patient DISS Suction System to Narkomed 2 or 2A

8.1.

CONVERSION KIT S000090 A
LOW FLOW & ELIMINATION OF MINIMUM FLOW - NARKOMED 2A

PART	PART DESCRIPTION	QTY.
4107094 T	Housing restrictor w/ pres tap	1
4107095 P	Label - blue 3/8 x 1-1/2	1
4102724 P	Gasket - large	1
1101872 P	O-ring Neoprene	1
4103445 P	Fitting - Br 10-32 x 1/16 hose barb	2
4102165 P	Washer - Neoprene	3
7704009 P	Screw set cup point 10-32 x 1/4 L ss	1
4102164 P	Reducer 1/4 OD 1/8 OD hose	1
8808007 P	Hose - Clear flex 1/4 OD x .060 W	6
S8808003 P	Hose - Clear flex	5
4106068 P	Tie strap - black	5
4105757 P	Tube FM - N_2O 20 - 500 ml/9-3/8"	1
4105758 P	Tube FM - N_2O .6-10 L/10"	1
4105722 P	Label - Caution Flow Operator	1
7702011 P	Screw pan head sltd 6-32 x 3/8 L ss	4
7750003 P	Hex nut 6-32 ss	4
4107698 P	Tube FM - O_2 20 - 500 ml/9-3/4	1
4107699 P	Tube FM - O_2 .6-10 L/10"	1
7751000 P	Nut acorn 10-32 Br Crpl	1

8.2. DPM-S INTERFACE KIT S000114 A

See procedure 3.4.0.0.

8.3.

TIDAL VOLUME LOCK BAR
4105620 - COMPLETE KIT

PART	PART DESCRIPTION	QTY.
1101089 P	Gasket	1
1101307 P	Gasket - bushing	1
1101412 P	Gear	1
4101872 P	O-ring	2
4102966 P	Spring	1
4103048 P	Ball bearing	4
4103049 P	Short spring	4
4104444 F	Block	1
4104447 F	Tube	1
4104449 F	Knob	1
4104488 F	Rack solder assembly	1
4104687 P	Shaft	1
4104712 M	Friction bushing	1
MISC	6-32 x 3/16" long cone point set screw	6
7707003 P	6-32 x 1/4" long cone point set screw	2
7707004 P	8-32 x 1/4" long cone point set screw	1

8.4. CONVERSION OF VENTILATOR RELIEF VALVE TO BELLOWS DOME

PART	PART DESCRIPTION	QTY.
4104769 A	Scavenger hose	2
4103957 M	Hose adapter	1
4105309 A	Relief valve conversion kit	1

8.5. PATIENT DISS SUCTION SYSTEM S000116 A

Contact the
NAD Technical Service Department
for information

NORTH
AMERICAN
DRÄGER

Quality Service for Life®

Technical Service Department
3122 Commerce Drive
Telford, PA 18969
(215) 721-5402
(800) 543-5047
(215) 723-5935 Fax

Part Number: S002010 (NARKOMED 2A Technical Service Manual)

Rev: A
Date: May 20, 1994
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Tab 6

NORTH
AMERICAN
DRÄGER

TECHNICAL SERVICE MANUAL

NARKOMED 2A PARTS

LIST OF EFFECTIVE PAGES

Dates of issue for original and changed pages are:

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Rev. A: 20 May 1994 Created NM2A Parts Manual (was part of NM2A Service Manual)

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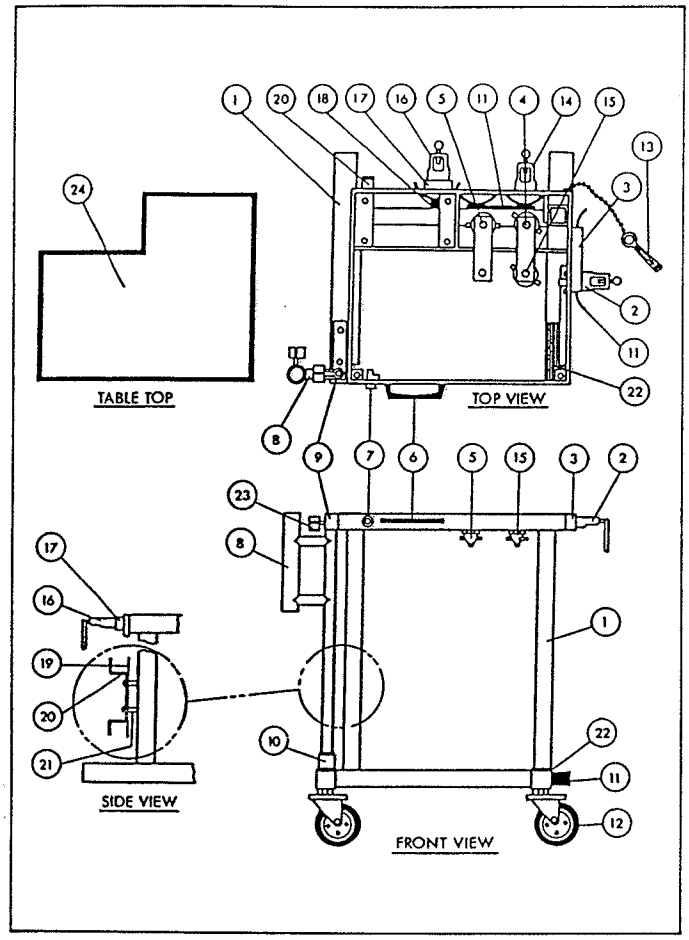
ABBREVIATIONS

AM III	Anesthesia Machine III
APL	Adjustable Pressure Limiter
AV	Anesthesia Ventilator
AV-E	Anesthesia Ventilator Electronic
AVM	Anesthesia Ventilator Mobile
AMP	Amperes
br	Brass
BO	Black Oxidized
BP	Blood Pressure
Btn	Button
Cd	Cadmium
cm H_2O	Centimeter of Water Pressure
corr	Corrugated
CO_2	Carbon Dioxide
CP	Chrome Plated
Cu	Copper
D	Diameter
DISS	Diameter Index Safety System
DPM-S	Drager Pressure Monitor - Self Diagnostic
Flt	Flat
flex	Flexible
Hd	Head
ID	Inside Diameter
I:E	Inspiratory/Expiratory Ratio
IL	Instrument Laboratory
L	Length
M	Metric
mm	Millimeters
mm Hg	Millimeters of Mercury Pressure
MPL	Micro Pneumatic Logic
NAD	North American Dräger
NC	Normally Closed
NMS	Narkomed Standard
NM2	Narkomed 2
NM2A	Narkomed 2A
NO	Normally Open
NP	Nickel Plated
NPT	National Pipe Thread
N_2	Nitrogen
NY	Nyloc
OFP	Oxygen Failure Pressure
ORM	Oxygen Ratio Monitor
ORMc	Oxygen Ratio Monitor Controller
O_2	Oxygen
Plt	Plated
PO_2	Polarographic
psi	Pounds Per Square Inch
PVC	Poly Vinyl Chloride
Pt	Point
Rd	Round
Skt	Socket
Sltd	Slotted
Sphyg	Sphygmomanometer
S	Steel
ss	Stainless Steel
Thk	Thick
VDC	Volts Direct Current
w/	With
w/o	Without
ZP	Zinc Plated

Frame Assembly Narkomed 2A

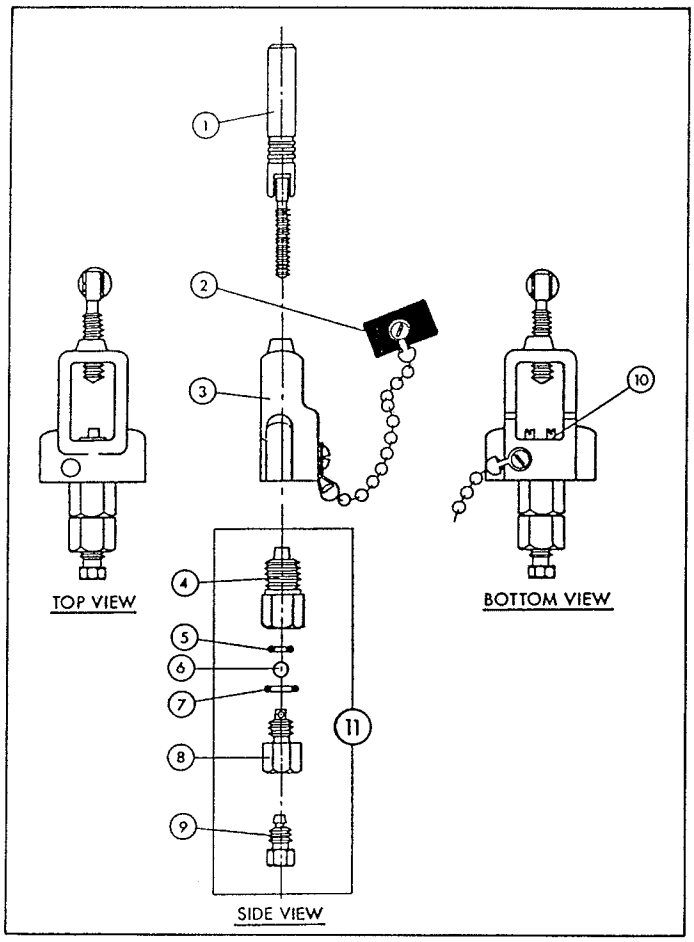
4103314 - A



1. 4103246 F Frame Weld Assembly
2. 1101640 A Yoke Assembly O_2
3. 4102662 F Yoke Spacer Double
4. 4103591 P Regulator N_2O
5. 4103590 P Regulator O_2
6. 2208115 P Handle
7. 4103385 A Flush Assembly O_2
8. 4105883 A Absorber Extension Arm Assembly - long
9. 1101519 A Swivel Bracket Assembly
10. 4102612 F Bracket Stop Assembly
11. 4105532 F Cylinder Support Assembly Double
12. 4105284 P Castor - 5 inch Conductive (4x)
13. 1100623 A Cylinder Wrench Assembly
14. 1101641 A Yoke Assembly N_2O
15. 4103590 P Regulator O_2
16. 1101645 A Yoke Assembly Air
17. 1101593 F Yoke Spacer Single
18. 4106690 F Cylinder Support Assembly Single
19. 4105907 F Strap Hose Bracket Back
20. 4105637 F Hose Bracket
21. 1101516 M Spacer Aluminum (2x)
22. 1101359 P Foot Pad
23. 1100078 P Wing Screw (2x)
24. 4103367 A Table Top Assembly

O_2 Yoke Assembly With Check Valve

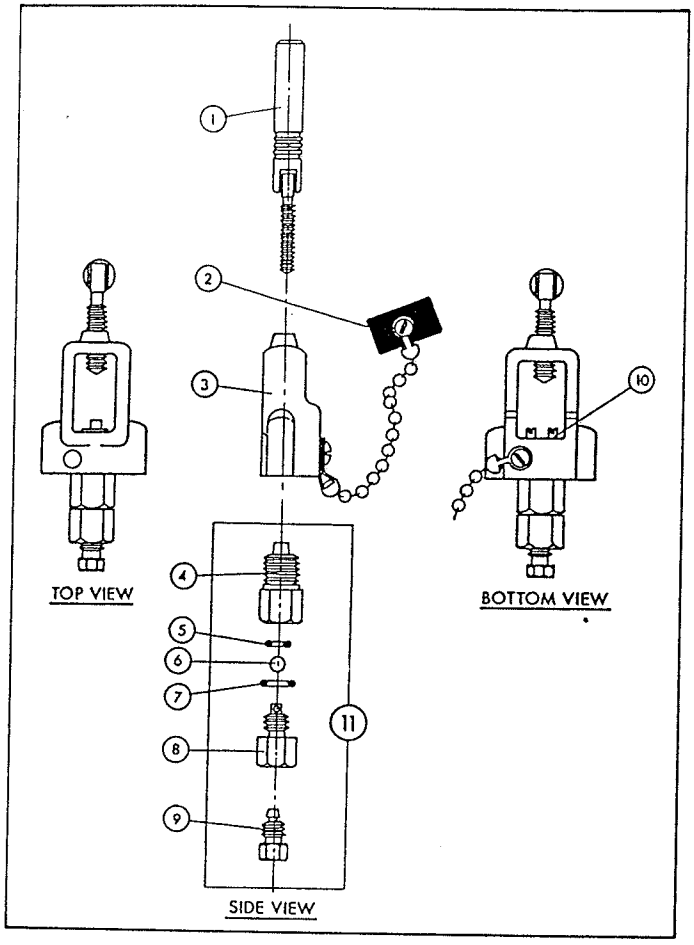
1101640 - A



1. 1101594 A Yoke Handle
2. 1101653 A Yoke Plug
3. 1101620 F Yoke O_2
4. 1101617 A Valve Body Assembly
5. 1101615 P O-Ring 006 - Teflon
6. 1101637 P Ball
7. 1101780 P O-Ring 011 - Neoprene
8. 1101793 M Valve Connector
9. 4104716 P Nut 3/16
10. 4105929 M Pin Yoke Index
11. 1101636 A Yoke Check Valve Assembly

N_2O Yoke Assembly With Check Valve

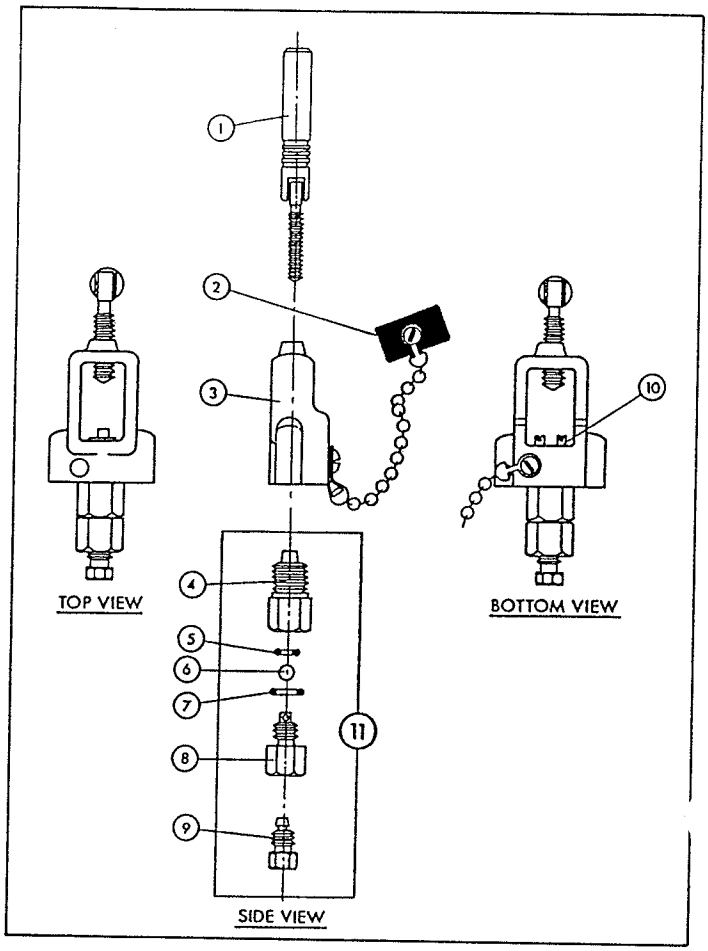
1101641 - A



1.	1101594 A	Yoke Handle
2.	1101653 A	Yoke Plug
3.	1101621 F	Yoke N_2O
4.	1101617 A	Valve Body Assembly
5.	1101615 P	O-Ring 006 - Teflon
6.	1101637 P	Ball
7.	1101780 P	O-Ring 011 - Neoprene
8.	1101793 M	Valve Connector
9.	4104716 P	Nut 3/16
10.	4105929 M	Pin Yoke Index
11.	1101636 A	Yoke Check Valve Assembly

Air Yoke Assembly With Check Valve

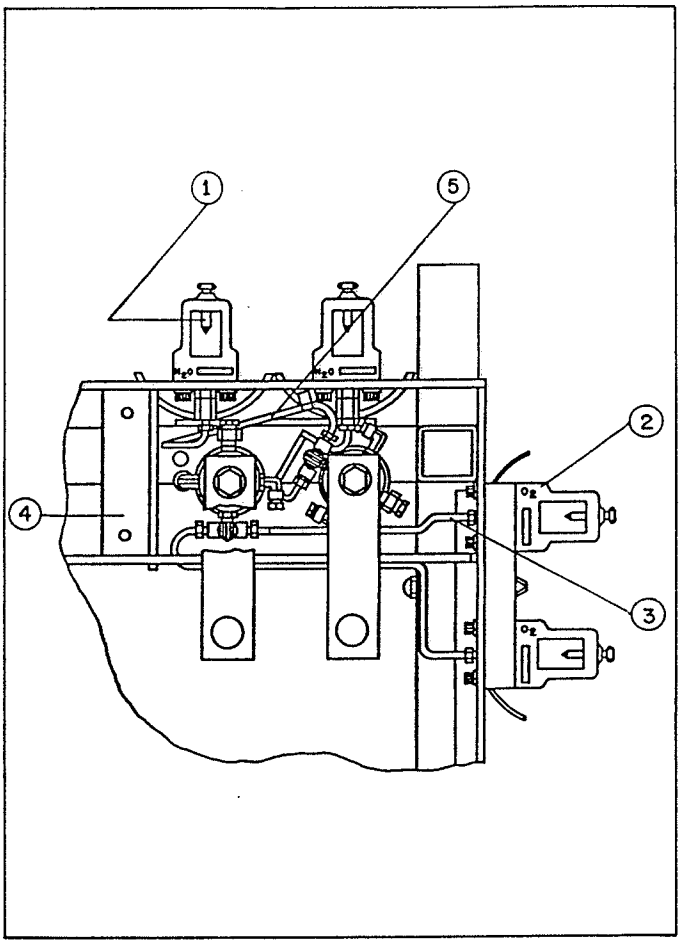
1101645 - A



1.	1101594 A	Yoke Handle
2.	1101653 A	Yoke Plug
3.	1101625 F	Yoke Air
4.	1101617 A	Valve Body Assembly
5.	1101615 P	O-Ring 006 - Teflon
6.	1101637 P	Ball
7.	1101780 P	O-Ring 011 - Neoprene
8.	1101793 M	Valve Connector
9.	4104716 P	Nut 3/16
10.	4105929 M	Pin Yoke Index
11.	1101636 A	Yoke Check Valve Assembly

NM2A 2 O_2 / 2 N_2O Yoke

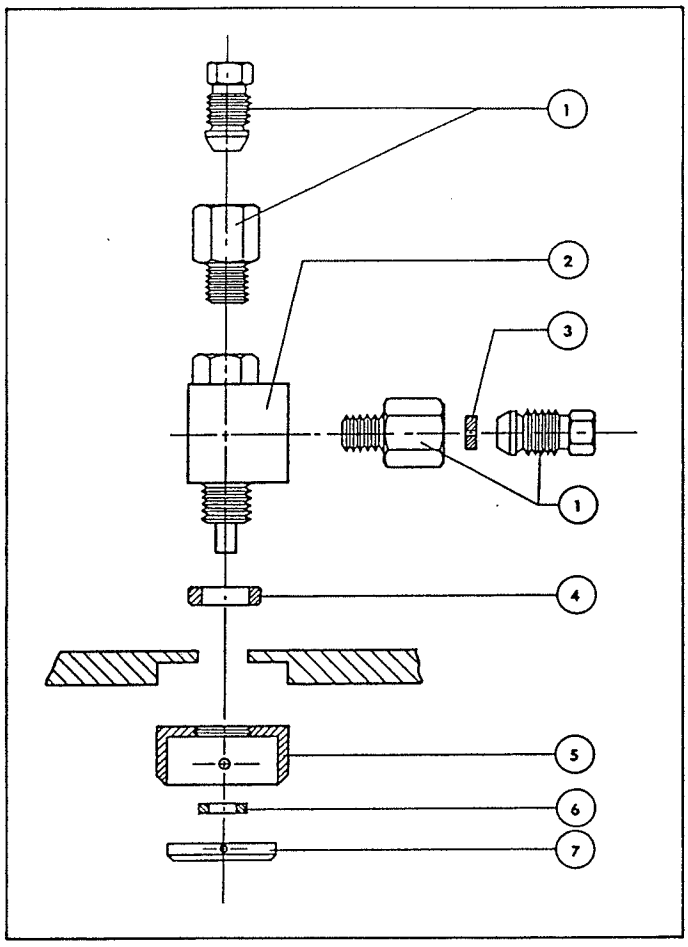
4104039 - A



1.	1101641 A	Yoke Assembly N_2O
2.	1101640 A	Yoke Assembly O_2
3.	4104182 M	Tubing - 3/16 OD Cu
4.	4104036 A	NM2A - O_2 / N_2O
5.	4104183 M	Tubing - 3/16 OD Cu

O_2 Flush Assembly NM2A

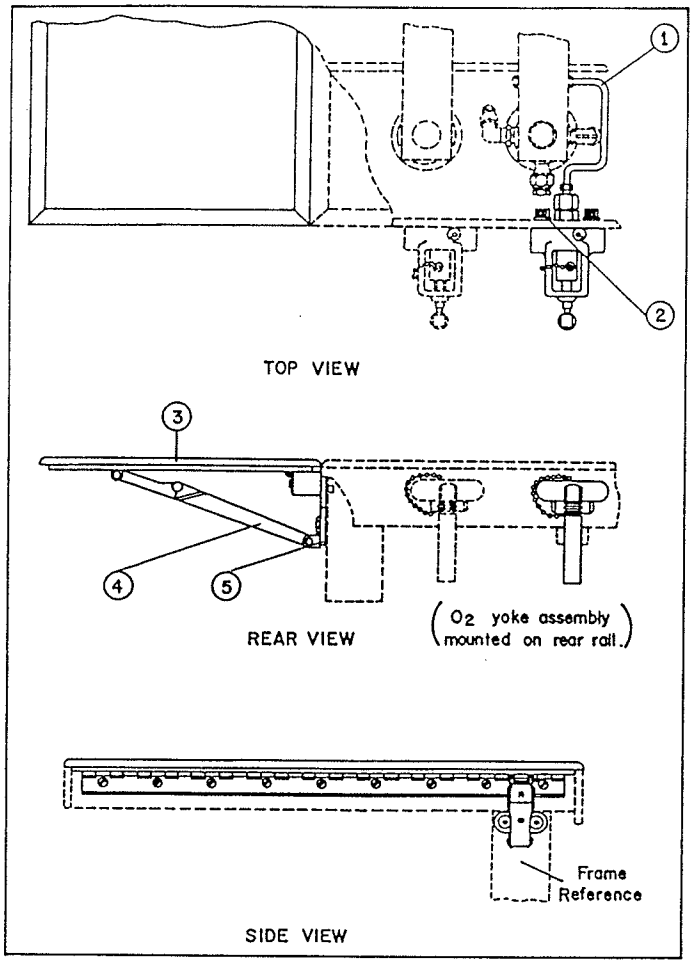
4103385 - A



1.	4102723 P	Connector - Male 1/4 D to 1/8 NPT (2x)
2.	4103340 P	Valve - Clippard
3.	4101867 M	Constriction
4.	4103703 M	Spacer Bar
5.	4103248 F	Knob
6.	7766003 P	Washer - Flat 10 ss .049 Thk
7.	4103249 F	Button

Drop Leaf Table Top

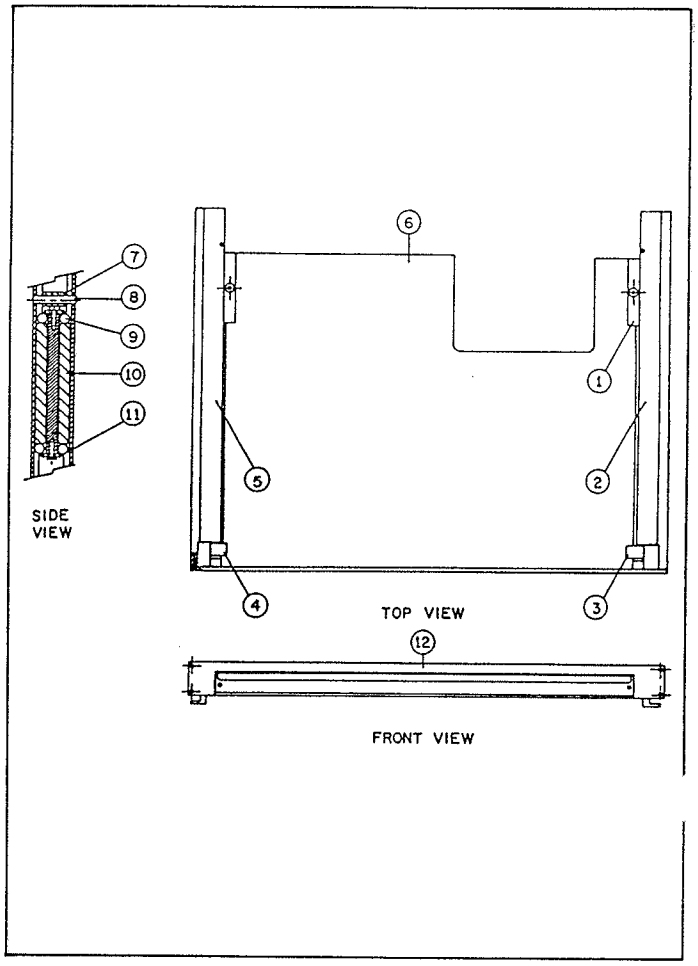
4106860 - A



1. 4106873 M Tubing - 3/16 OD Cu
2. 7701056 P Screw - Cap Skt Hd 5/16-24 x 3/4 L ss
3. 4106861 A Drop Leaf Sub-Assembly
4. 4106872 P Support Drop Leaf
5. 4107098 F Spacer Plate

Writing Tray Assembly

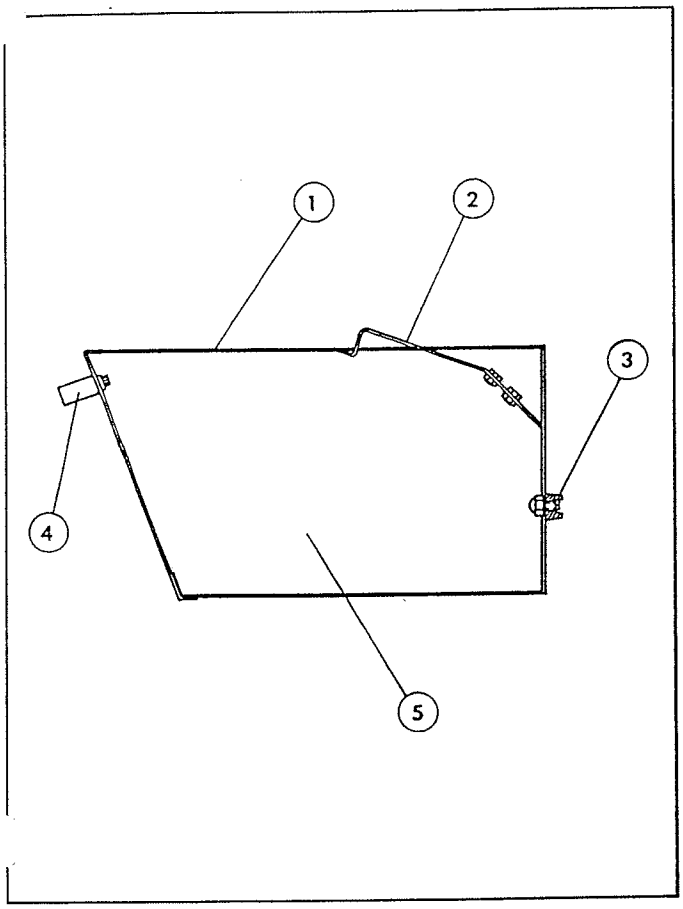
4103820 - A



1. 4106832 F Slide Writing Tray (2x)
2. 4106829 F Side Channel - right
3. 4106827 M Guide Writing Tray - right
4. 4106828 M Guide Writing Tray - left
5. 4106830 F Side Channel - left
6. 4106824 A Writing Tray Assembly
7. 4103782 P Swivel Plug
8. 7775005 P Pin - Roll .250 D x 1 L ss (2x)
9. 4106836 P Ball - 3/16 ss (8x)
10. 4106835 M Rod Ball Spacer (4x)
11. 4106834 M Retainer Ball (4x)
12. 4106821 F Weld Assembly Writing Tray Front

Drawer Assembly Single

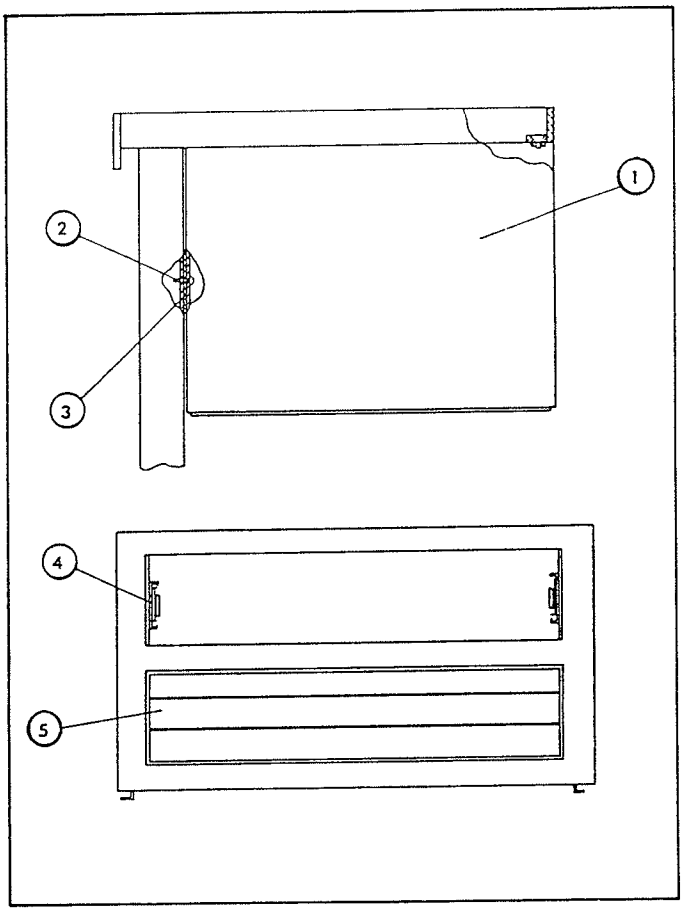
1100318 - A



1. 4102975 P Guide Strip (2x)
2. 1101370 P Spring (2x)
3. 1101752 P Screw Bumper (2x)
4. 2208115 P Handle
5. 1100461 F Drawer - large

Drawer Assembly Double

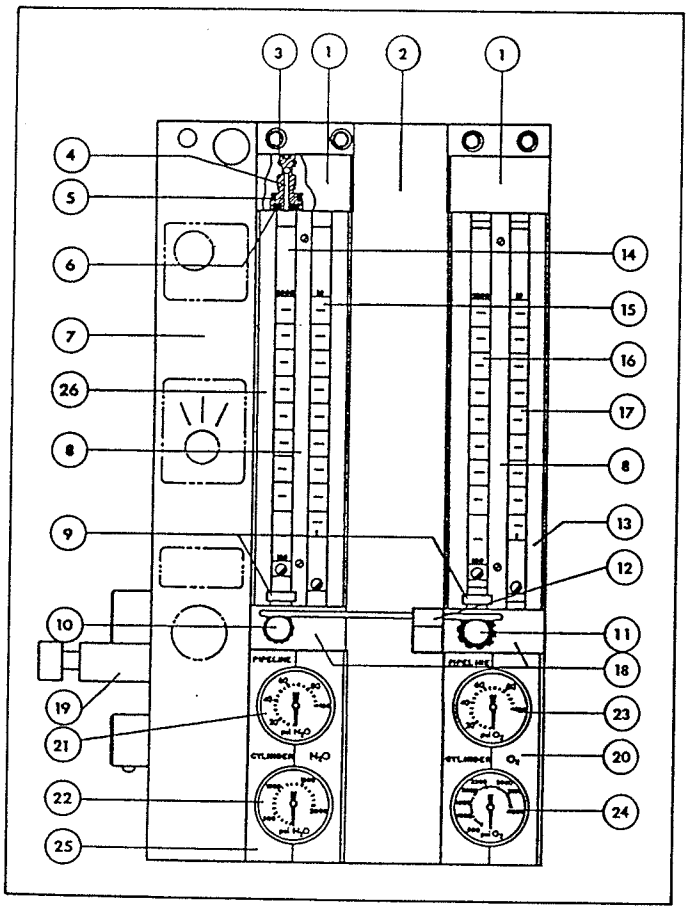
1100321 - A



1. 4102627 A Two Drawer Sub-Assembly
2. 7706007 P Screw - Rd Hd Sltd 10-32 x 1/2
3. 1101375 M Spacer - use as needed (2x)
   1101376 M Spacer - use as needed (2x)
   1101377 M Spacer - use as needed (2x)
4. 4104620 P Sliding Glide Rail (4x)
5. 1100319 F Drawer Assembly

Flowmeter Assembly NM2A 2 Gas (Front View)

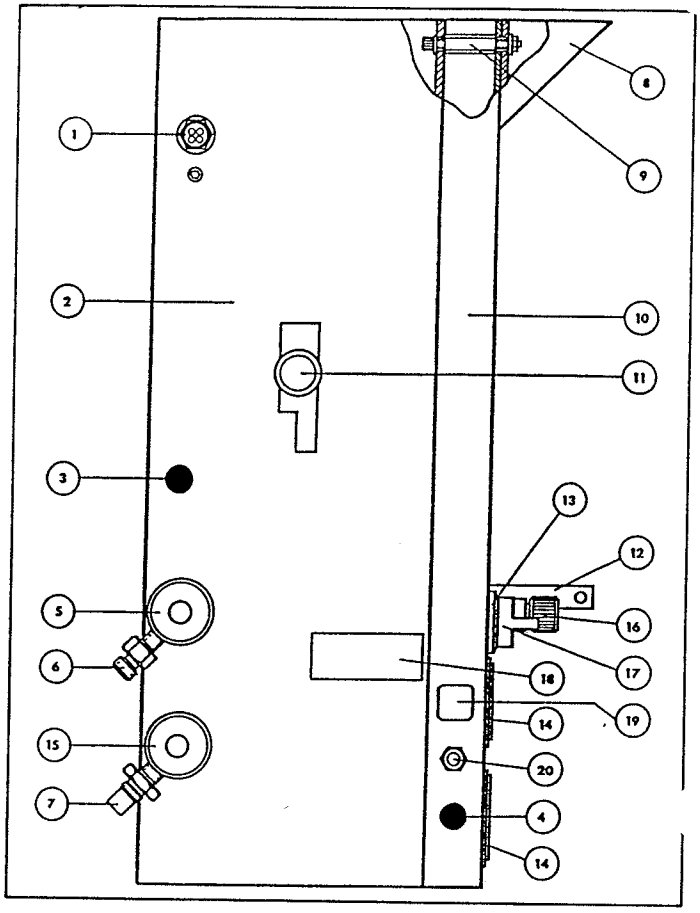
4104053 - A



1.	4103171 F	Flowmeter Block Top (2x)
2.	4106220 A	Center Channel Assembly (4x)
3.	4101872 P	O-Ring 010 - Neoprene (4x)
4.	4102506 P	Connector (4x)
5.	4102793 P	O-Ring 111 - Neoprene (4x)
6.	4102724 P	Gasket - large (8x)
7.	4106053 A	Alarm Panel Assembly
8.	4103307 M	Flowmeter Shield 1 Gas (2x)
9.	4103440 T	Restrictor Housing (2x)
10.	4103736 A	Flow Knob Assembly
11.	4103156 A	Flow Knob O_2
12.	4106219 A	Flow Control Knob Protection
13.	4103322 F	Flowmeter Mount
14.	4103419 P	Flowmeter Tube N_2O (Fine)
15.	4103420 P	Flowmeter Tube N_2O (Coarse)
16.	4103417 P	Flowmeter Tube O_2 (Fine)
17.	4103418 P	Flowmeter Tube O_2 (Coarse)
18.	4103172 F	Flowmeter Block Bottom
19.	4103413 A	Common Outlet Assembly
20.	4104163 S	Box Section Gauge O_2
21.	4103100 P	Gauge - Pipeline N_2O
22.	4103075 P	Gauge - Cylinder N_2O
23.	4103076 P	Gauge - Pipeline O_2
24.	4103074 P	Gauge - Cylinder O_2
25.	4104162 S	Box Section Gauge N_2O
26.	4103173 F	Flowmeter Mount N_2O

Flowmeter Assembly NM2A 2 Gas (Side View)

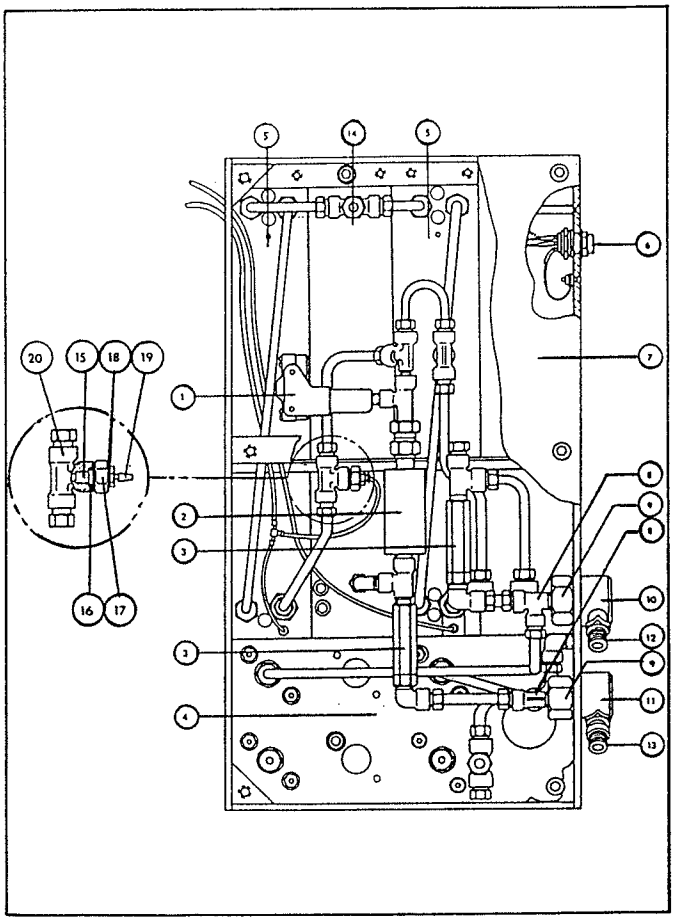
4104053 - A



1.	4106265 A	Plug Assembly - 4 Pin Power
2.	4103329 F	Flowmeter Housing Assembly
3.	4104417 P	Plug 3/4 D
4.	4103369 P	Plug 7/16 D
5.	4102559 F	Inlet Housing O_2
6.	4102563 P	Connector - DISS O_2 Male
7.	4102575 P	Connector - DISS N_2O Male
8.	4103357 F	Front Cover Assembly
9.	4103587 P	Spacer Bar (2x)
10.	4106053 A	Alarm Panel Assembly
11.	4104339 A	Mount Assembly IL
12.	4106219 A	Flow Control Knob Protection Assembly
13.	4106049 M	Bezel
14.	4103624 M	Gauge Cover
15.	4102607 F	Inlet Housing N_2O
16.	4103736 A	Flow Knob Assembly
17.	4103169 F	Knob
18.	4103413 A	Common Outlet Assembly
19.	4103956 F	BP Gauge Jack
20.	4103577 F	Disconnect - Female Adapter

Flowmeter Assembly NM2A 2 Gas (Rear View)

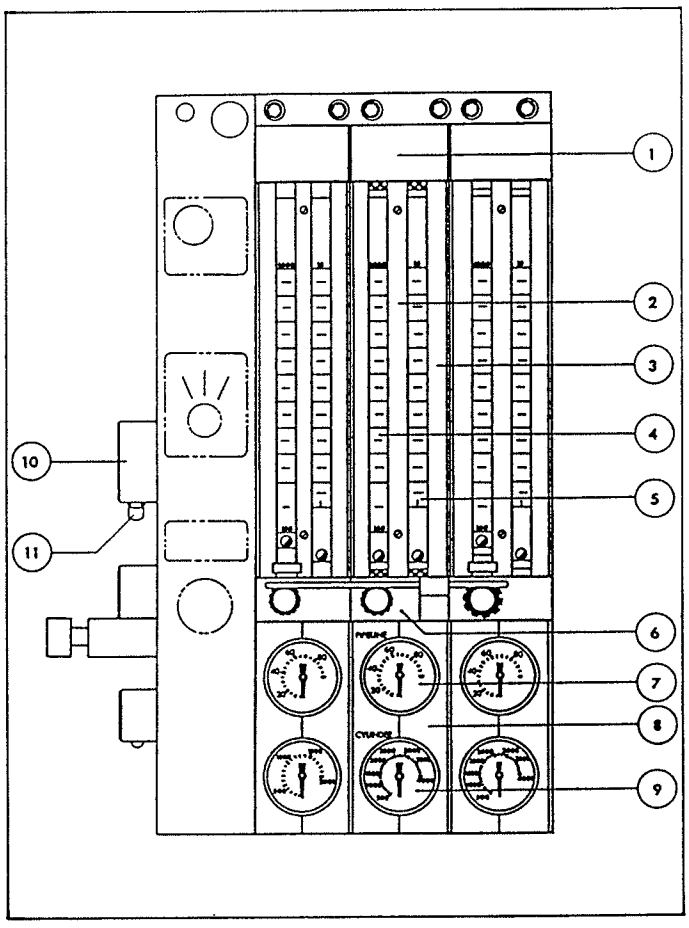
4104053 - A



1.	4106037 P	Pressure Switch Adjustable
2.	4102713 P	OFP Device
3.	4105815 P	Check Valve Pipeline
4.	4103329 F	Flowmeter Housing Assembly
5.	4103322 F	Flowmeter Mount Assembly
6.	4106265 A	Plug Assembly 4 Pin Power
7.	4103294 S	Cover Flowmeter Back
8.	4106198 A	Filter Assembly Pipeline (2x)
9.	7752003 P	Nut - Hex Jam 3/4-16 ss (2x)
10.	4102559 F	Inlet Housing O_2
11.	4102607 F	Inlet Housing N_2O
12.	4102563 P	Connector - DISS O_2 Male
13.	4102575 P	Connector - DISS N_2O Male
14.	4106220 A	Center Channel Assembly
15.	4103686 P	Restrictor - Minimum Flow (Green)
16.	4101872 P	O-Ring 010 - Neoprene
17.	4103592 M	Restrictor Housing
18.	4102165 P	Washer - Neoprene
19.	4103445 P	Straight Fitting
20.	4102770 P	Tee - Female Branch 1/4 to 1/8 NPT

Gas Circuit - Cylinder & Pipeline Air (Front View)

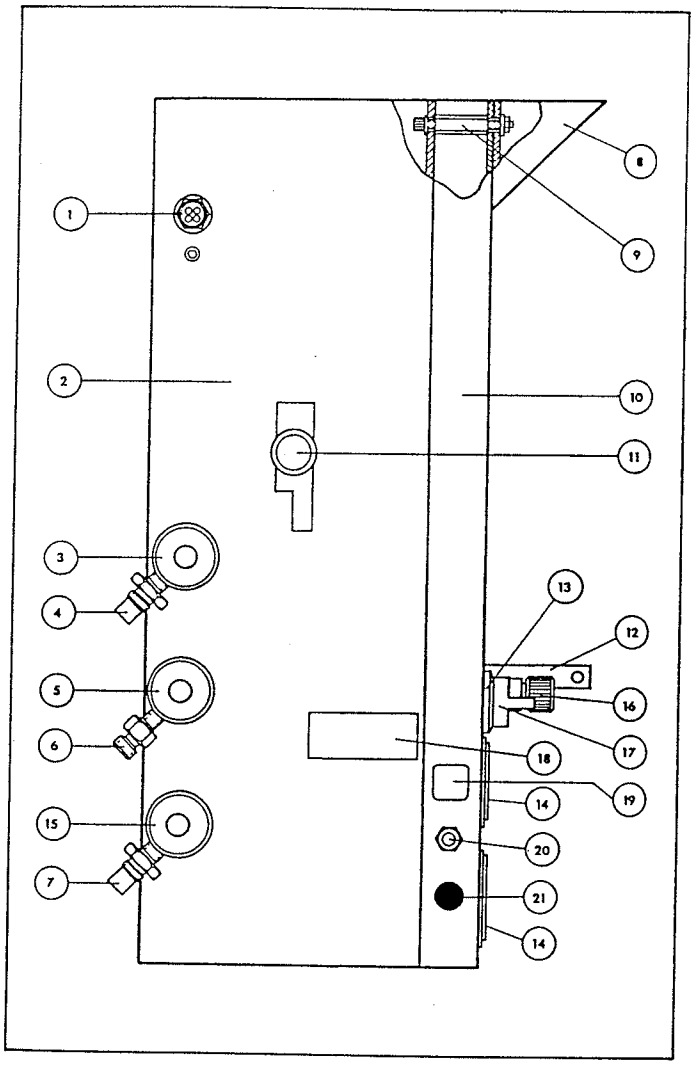
4104042 - A



1.	4103171 F	Flowmeter Block Top
2.	4103538 M	Flowmeter Shield 3 Gas
3.	4103174 F	Flowmeter Mount Center
4.	4106692 P	Flowmeter Tube Air (Fine)
5.	4106693 P	Flowmeter Tube Air (Coarse)
6.	4106069 F	Flowmeter Block Bottom Center
7.	4103666 P	Gauge - Pipeline Air
8.	4104431 S	Gauge - Channel Air
9.	4102827 P	Gauge - Cylinder Air
10.	4102559 F	Inlet Housing Air
11.	4102886 P	Connector - DISS Air Male
		Items Not Shown
12.	4104735 M	Shield Flowmeter 3 Gas with Flowmeter Lights

Flowmeter Assembly NM2A 3 Gas (Side View)

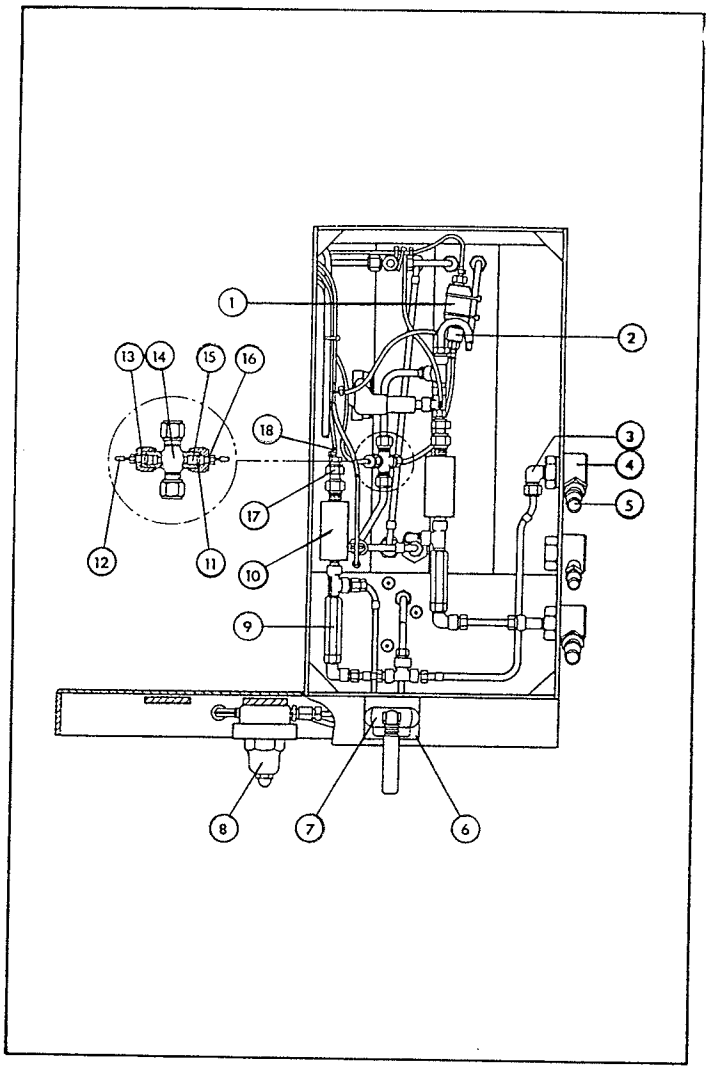
4104042 - A



1. 4106265 A Plug Assembly 4 Pin Power
2. 4103329 F Flowmeter Housing Assembly
3. 4102559 F Inlet Housing Air
4. 4102886 P Connector - DISS Air Male
5. 4102559 F Inlet Housing O_2
6. 4102563 F Connector - DISS O_2 Male
7. 4102575 M Connector - DISS N_2O Male
8. 4103357 F Front Cover Assembly
9. 4103587 P Spacer Bar (2x)
10. 4106053 A Alarm Panel Assembly
11. 4104339 A Mount Assembly IL
12. 4106219 A Flow Control Knob Protection
13. 4106049 M Bezel
14. 4103624 M Gauge Cover (6x)
15. 4102607 F Inlet Housing N_2O
16. 4103736 A Flow Knob Assembly
17. 4103169 F Knob
18. 4103413 A Common Outlet Assembly
19. 4103956 F BP Gauge Jack
20. 4103577 F Disconnect - Female Adapter
21. 4103369 P Plug 7/16 D

Air Gas Circuit Cylinder & Pipeline (Rear View)

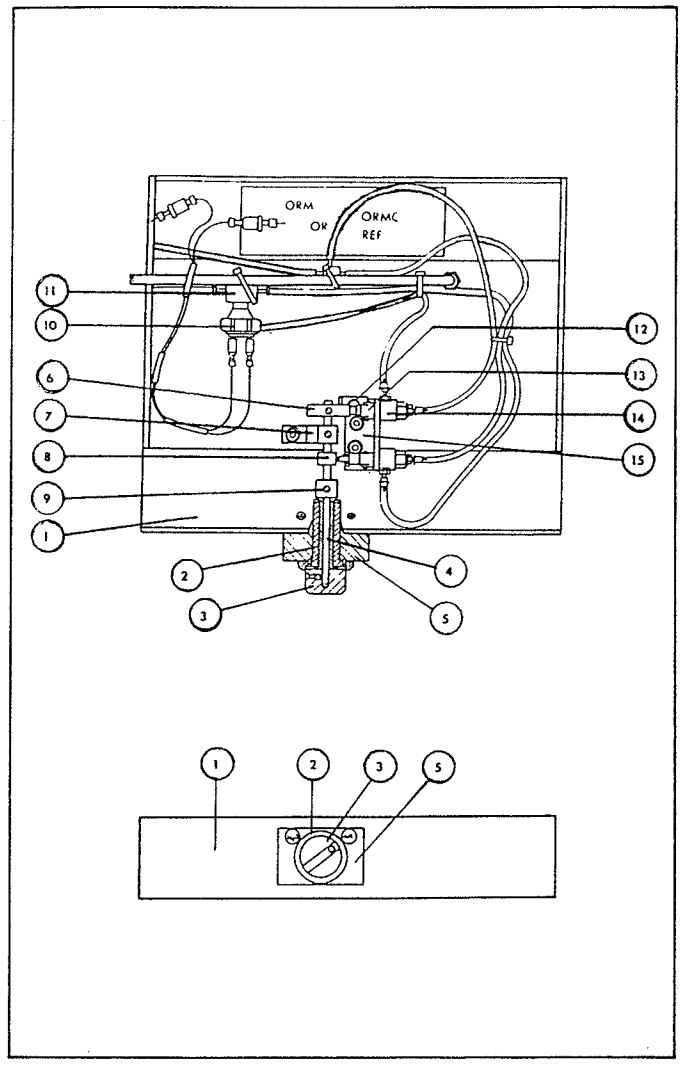
4104042 - A



1. 4102055 P Pilot Actuator
2. 4103549 P Valve 2 Way Poppet
3. 4106198 A Filter Assembly Pipeline
4. 4102559 F Inlet Housing Air
5. 4102886 P Connector - DISS Air Male
6. 1101593 F Yoke Spacer
7. 1101645 A Yoke Assembly Air
8. 4104603 A Regulator with Fitting Air
9. 4105815 P Check Valve Pipeline
10. 4102713 P OFP Device
11. 4101872 P O-Ring 010 - Neoprene (2x)
12. 4103445 P Straight Fitting (10x)
13. 4104842 M Barb Bushing
14. 4102772 P Cross 4 Way 1/4 to 1/4
15. 4103686 P Restrictor (Green)
16. 4102165 P Washer (10x)
17. 4103681 P Connector - DISS O_2 Female
18. 4106366 P Hose Barb 1/8 NPT to 1/16

Air/N_2O Switch Assembly Air Gas Ciruit NM2A

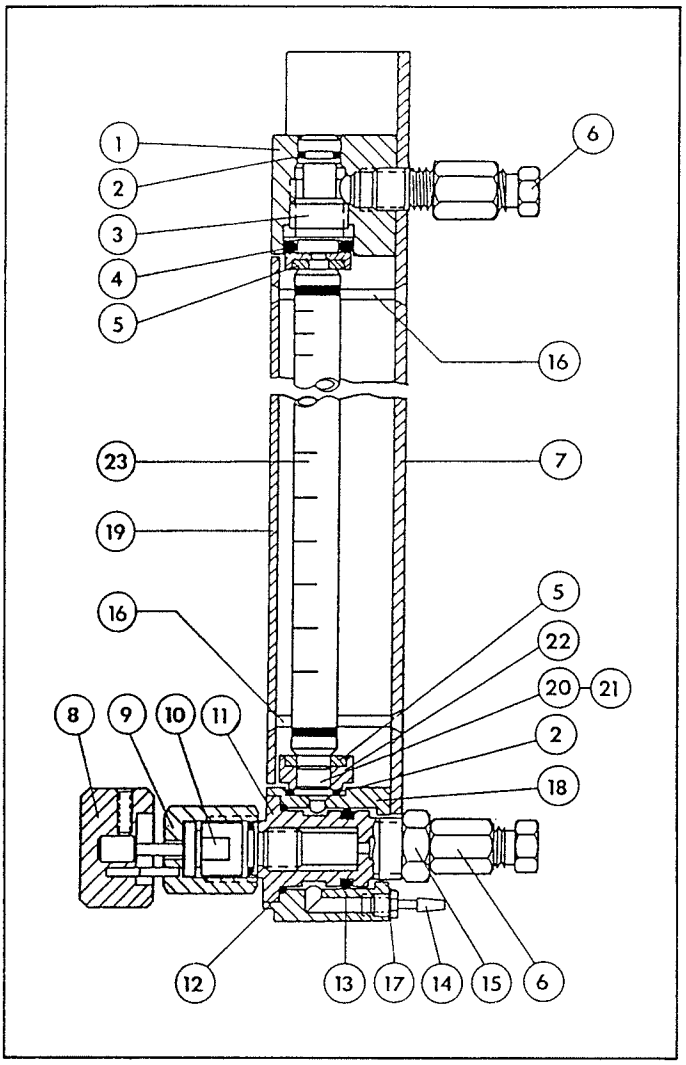
4104042 - A



1. 4105277 F Front Cover
2. 4104289 M Insert
3. 4103169 F Knob
4. 4104763 M Shaft
5. 4104765 F Block
6. 4103267 M Cam
7. 1101502 F Valve Spring
8. 4103315 M Cam
9. 4103401 M Switch Stop (2x)
10. 4103444 P Pressure Switch
11. 4106367 M Tee - Adapter 1/8 NPT
12. 4104372 M Bracket
13. 4103339 P Cam Follower (2x)
14. 4103621 P Valve 2 Way Poppet (2x)
15. 4104764 M Programmer Mount

Channel Assembly O_2 - NM2A

4103409 - A



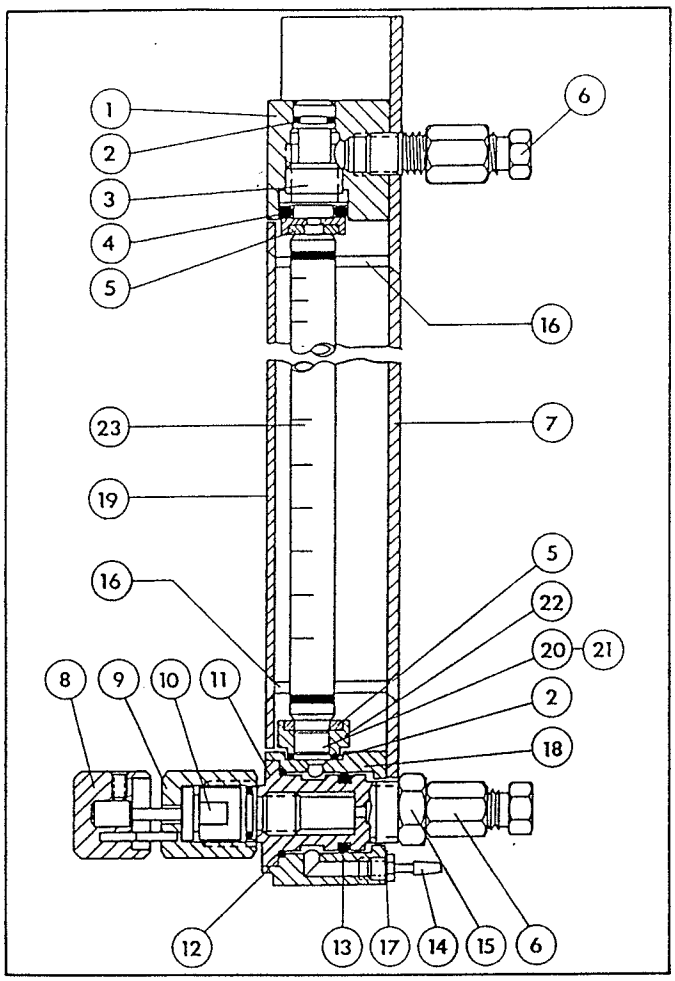
1. 4103171 F Flowmeter Block Top
2. 4101872 P O-Ring 010 - Neoprene (3x)
3. 4102506 P Connector (2x)
4. 4102793 P O-Ring 111 - Neoprene (2x)
5. 4102724 P Gasket - large (4x)
6. 4102723 P Connector - Male 1/4 D (4x)
7. 4103322 F Flowmeter Mount
8. 4103156 A Flow Control Knob O_2
9. 4103382 A Valve Kit Nut
10. 4103352 P Flow Control Valve
11. 4102511 F Insert
12. 4102336 P O-Ring 018 - Neoprene
13. 4102792 P O-Ring 113 - Neoprene
14. 4103445 P Straight Fitting
15. 4102513 M Nut
16. 4103259 M Shield Spacer (2x)
17. 4102165 P Washer - Neoprene
18. 4103172 F Flowmeter Block Bottom
19. 4103307 M Flowmeter Shield 1 Gas
20. 4103441 P Restrictor O_2 ORM (Black)
21. 4104622 P Restrictor O_2 ORMc (Red)
22. 4103440 T Restrictor Housing
23. 4103417 P Flowmeter O_2 (Fine)

Items Not Shown

24. 4103418 P Flowmeter O_2 (Coarse)

Channel Assembly N_2O - NM2A

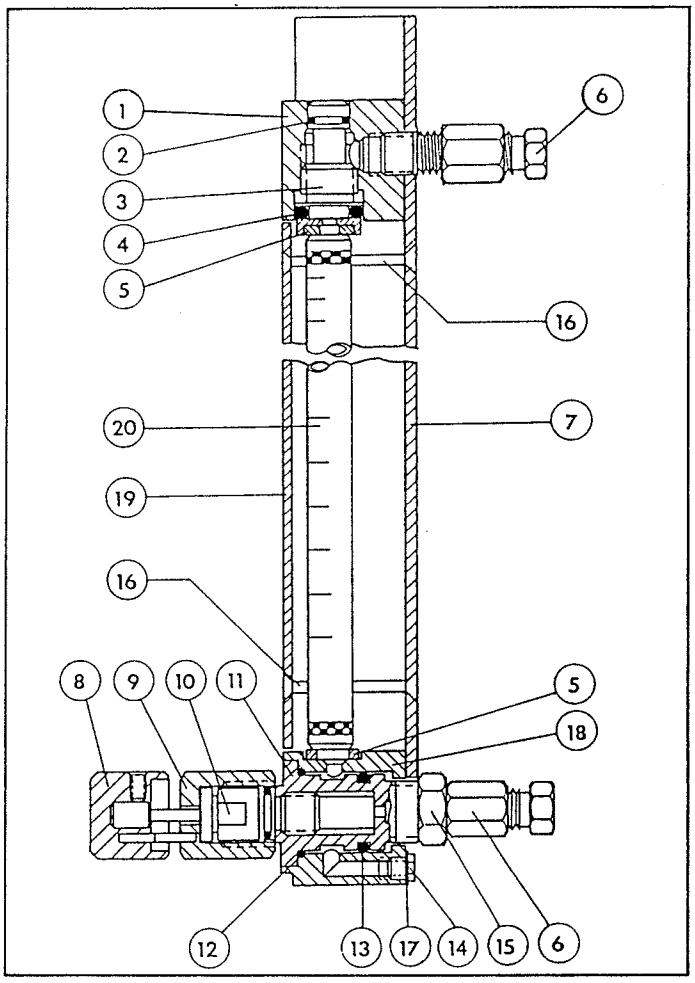
4103438 - A



1.	4103171	F	Flowmeter Block Top
2.	4101872	P	O-Ring 010 - Neoprene (3x)
3.	4102506	P	Connector (2x)
4.	4102793	P	O-Ring 111 - Neoprene (2x)
5.	4102724	P	Gasket - large (4x)
6.	4102723	P	Connector - Male 1/4 D to 1/8 NPT (4x)
7.	4103322	F	Flowmeter Mount
8.	4103736	A	Flow Control Knob Assembly
9.	4103382	A	Valve Kit Nut
10.	4103352	P	Flow Control Valve
11.	4102511	F	Insert
12.	4102336	P	O-Ring 018 - Neoprene
13.	4102792	P	O-Ring 113 - Neoprene
14.	4103445	P	Straight Fitting
15.	4102513	M	Nut
16.	4103259	M	Shield Spacer (2x)
17.	4102165	P	Washer - Neoprene
18.	4103172	F	Flowmeter Block Bottom
19.	4103307	M	Flowmeter Shield 1 Gas
20.	4103442	P	Restrictor N_2O ORM (Yellow)
21.	4104621	P	Restrictor N_2O ORMc (Blue)
22.	4103440	T	Restrictor Housing
23.	4103419	P	Flowmeter N_2O (Fine)
			Items Not Shown
24.	4103420	P	Flowmeter N_2O (Coarse)

Channel Assembly Air

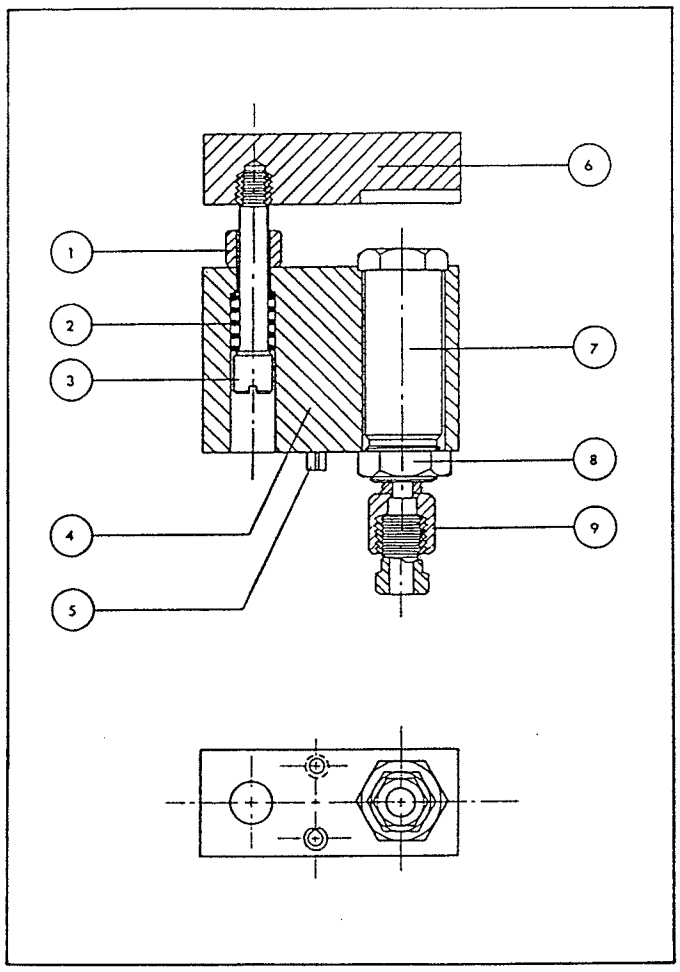
4103799 - A



1.	4103171	F	Flowmeter Block Top
2.	4101872	P	O-Ring 010 - Neoprene (2x)
3.	4102506	P	Connector (2x)
4.	S4102793	P	O-Ring 111 - Neoprene (2x)
5.	4102724	P	Gasket - large (4x)
6.	4102723	P	Connector - Male 1/4 D to 1/8 NPT (4x)
7.	4103174	F	Flowmeter Mount
8.	4103736	A	Flow Control Knob Assembly
9.	4103382	A	Valve Kit Nut
10.	4103352	P	Flow Control Valve
11.	4102511	F	Insert
12.	4102336	P	O-Ring 018 - Neoprene
13.	4102792	P	O-Ring 113 - Neoprene
14.	4103801	M	Plug
15.	4102513	M	Nut
16.	4103259	M	Shield Spacer (2x)
17.	4102165	P	Washer - Neoprene
18.	4106069	F	Flowmeter Block Bottom
19.	4103538	M	Flowmeter Shield 3 Gas
20.	4106692	P	Flowmeter Tube Air (Fine)
			Items Not Shown
21.	4106693	P	Flowmeter Tube Air (Coarse)

Common Outlet Assembly NM2A

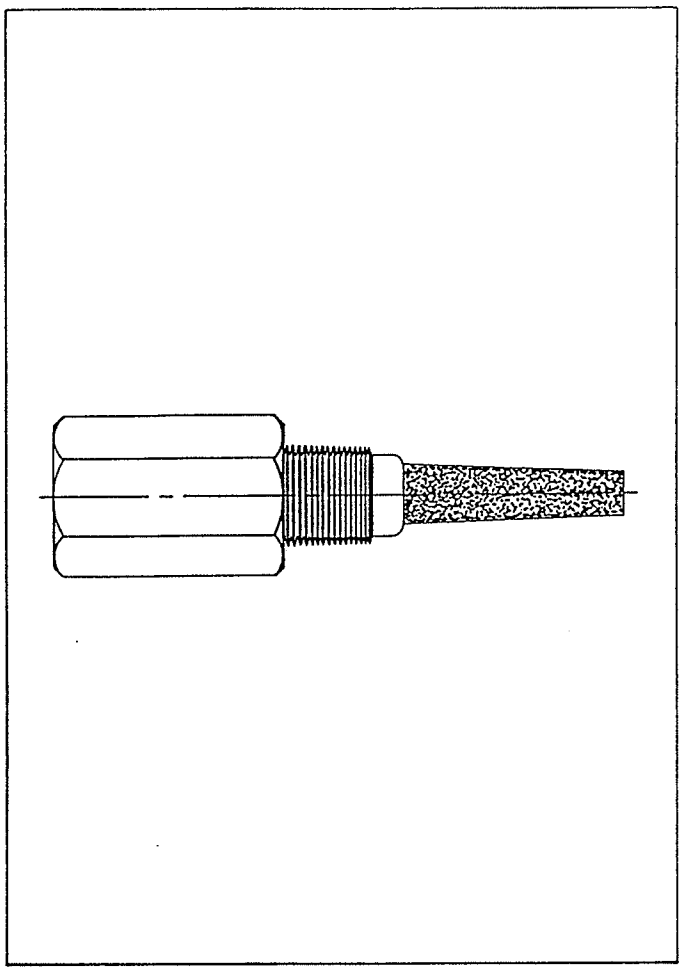
4103413 - A



1.	4103712 M	Spacer - Nylon
2.	4103455 P	Spring
3.	4103452 M	Shaft
4.	4103451 F	Block
5.	7775003 P	Pin - Roll .187 D x 5/8 L ss
6.	4103453 F	Block
7.	4103454 F	Common Outlet 15mm
8.	4103713 M	Nut
9.	4102723 P	Connector - Male 1/4 D to 1/8 NPT

Filter Assembly Pipeline

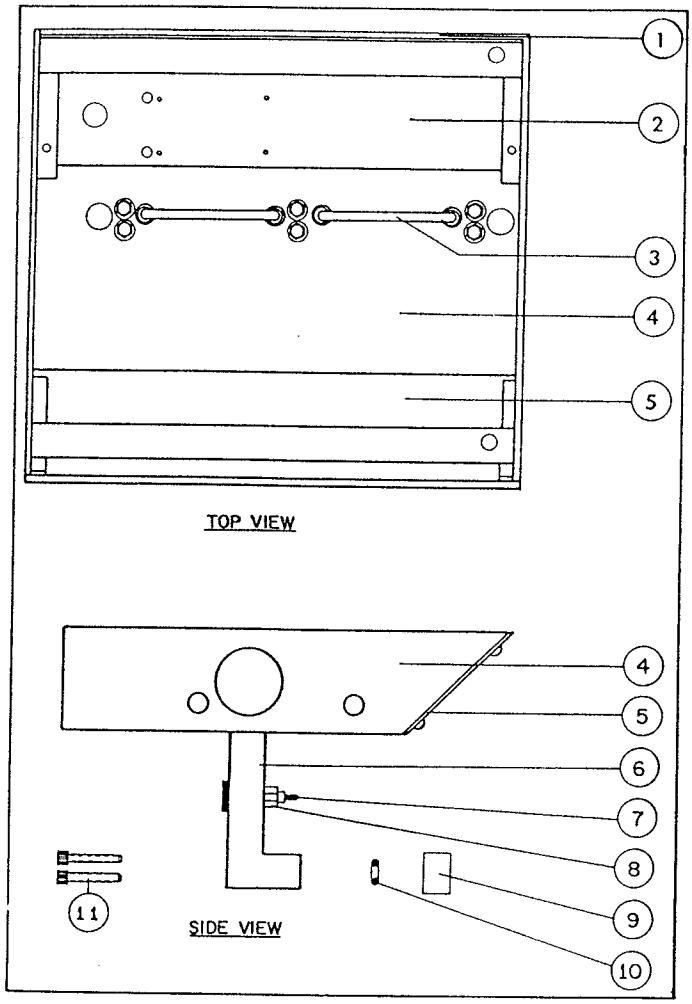
4106198 - A



1.	4106198 A	Filter Assembly Pipeline

Vapor Mounting Box Assembly

4104054 - A



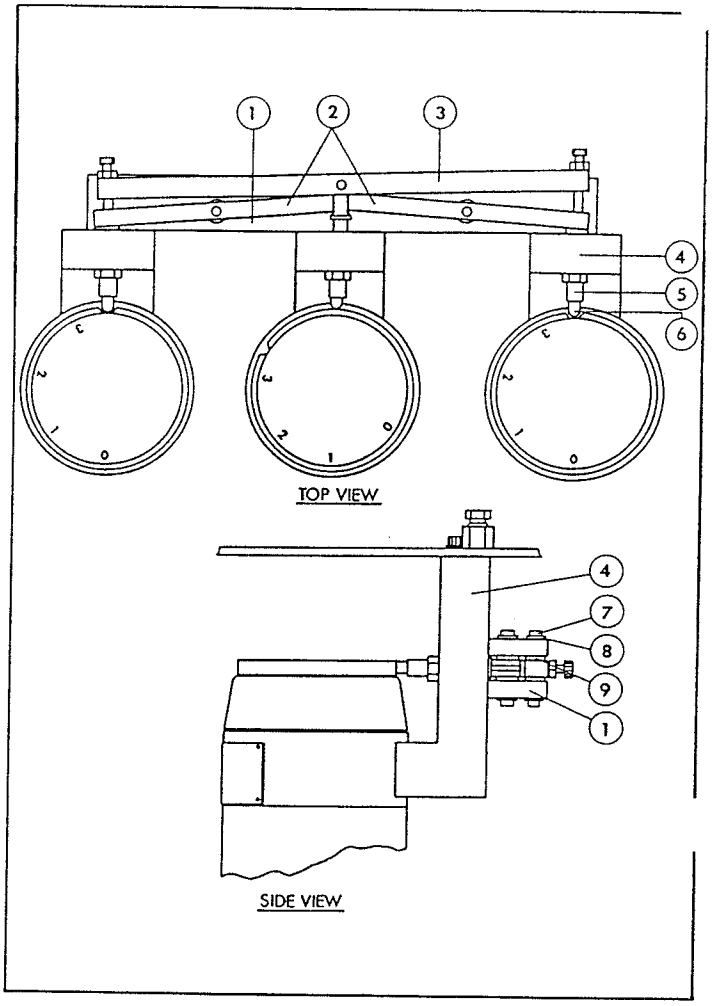
1. 4104952 F Back Panel
2. 4105202 M Bottom Plate - extended
3. 4104208 M Tubing - 1/4 OD Cu (2x)
4. 4104949 F Vapor Box - extended
5. 4104950 F Front Cover

Items Not Shown

6. 4103269 F Vapor Mount (3x)
7. 4104977 M Pin (3x)
8. 4104342 F Bushing (3x)
9. 4104530 F Vapor Short Circuit Block
10. 2121929 P O-Ring 107 - Viton (6x)
11. 7701072 P Screw - Cap Skt Hd M4 x .07 (6x)

3 Vapor Exclusion System NM2A

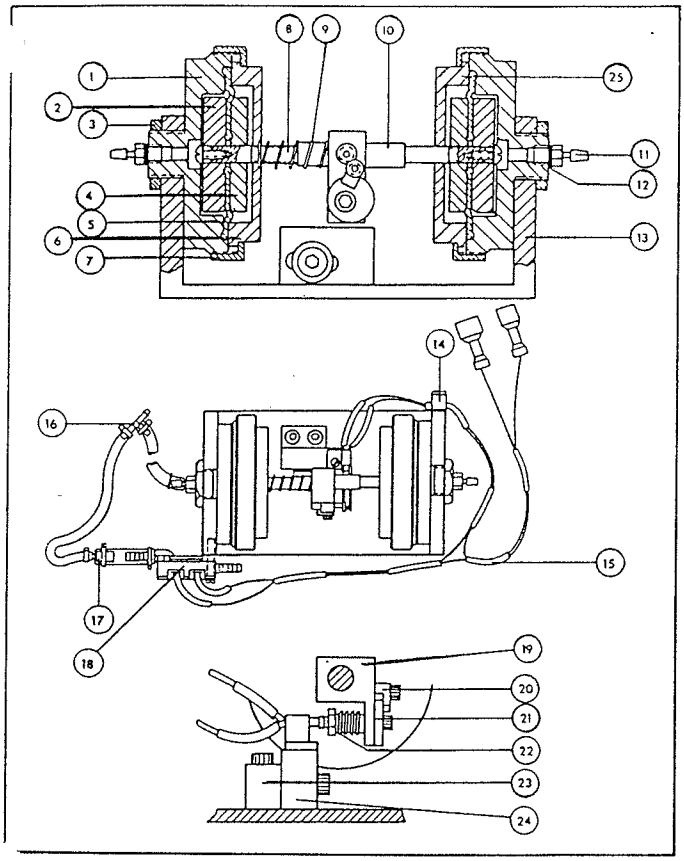
4104927 - A



1. 4104976 F Support Bar (2x)
2. 4104975 F Pivot Arm - short (2x)
3. 4104974 T Pivot Arm - long
4. 4103269 F Vapor Mount (3x)
5. 4104342 F Bushing (3x)
6. 4104977 M Pin (3x)
7. 4104343 M Shaft (3x)
8. 4103512 P Retainer Clip (6x)
9. 4104344 M Washer - Black Nylon (6x)

Oxygen Ratio Monitor Assembly NM2A

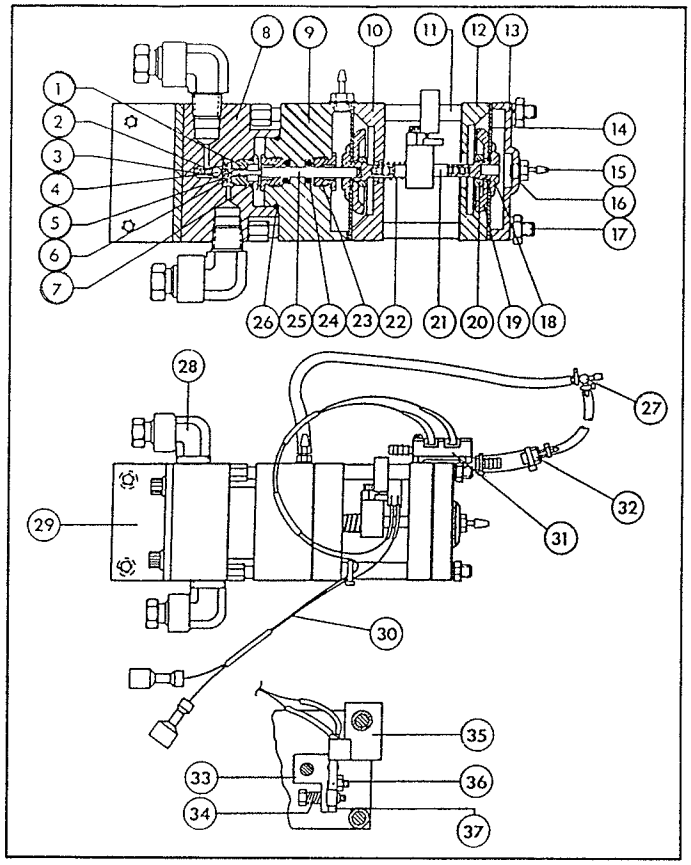
4106170 - A



1.	4103477 M	Plunger (2x)
2.	4103472 M	Plunger Back Plate (2x)
3.	7753002 P	Nut - Hex Panel 1/2-20 br (2x)
4.	4103473 M	Plunger Front Plate (2x)
5.	2121805 P	Diaphragm (2x)
6.	4103595 M	Cap
7.	2109228 F	Adapter (2x)
8.	4103470 M	Threaded Rod
9.	4103348 P	Spring
10.	4103471 M	Connecting Rod
11.	4103445 P	Straight Fitting (2x)
12.	4102165 P	Washer - Neoprene (2x)
13.	4103469 M	ORM Housing
14.	4105735 M	Wire Clamp
15.	4105738 A	Wire Harness ORM
16.	4102337 P	Tee
17.	4102164 P	Reducer
18.	4105126 P	Switch - MPL 8cm H_2O NO
19.	4105739 M	Cam Bracket
20.	4105681 M	Cam Lock
21.	4105679 M	Cam
22.	4105682 P	Spring
23.	4105737 M	Block
24.	4105736 M	Switch Mount
25.	4103475 M	Cap
		Items Not Shown
26.	4103441 P	Restrictor O_2 ORM (Black)
	4103442 P	Restrictor N_2O ORMc (Yellow)
	4103440 T	Restrictor Housing (2x)

Oxygen Ratio Monitor Controller NM2A

4104000 - A

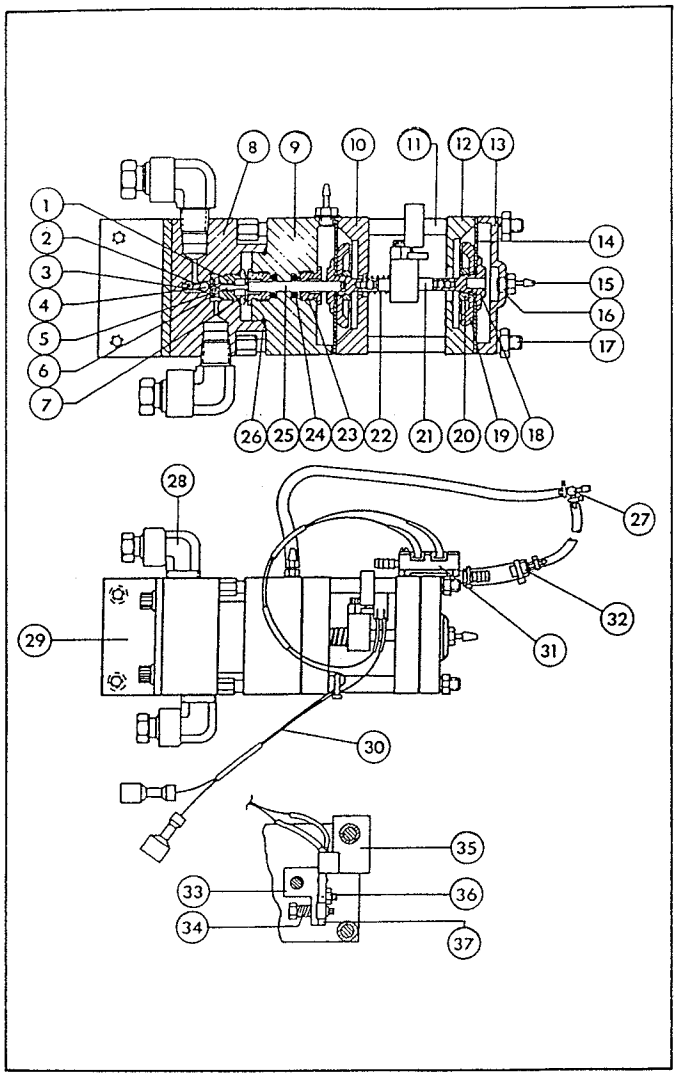


1.	4104569 P	Valve Nut
2.	4104623 P	Ball Seat
3.	4104566 P	Spring
4.	4104567 P	Ball
5.	4104568 P	Ball Seal
6.	4104570 P	Plunger Pin
7.	1101780 P	O-Ring 011 - Neoprene
8.	4104565 M	Valve Housing
9.	4104575 M	Housing
10.	4104571 M	Housing
11.	4104586 M	Spacer (4x)
12.	4104584 M	Housing
13.	4104587 M	Housing
14.	4104581 P	Diaphragm (2x)
15.	4103445 P	Straight Fitting (2x)
16.	4102165 P	Washer - Neoprene (2x)
17.	4104588 M	Rod (4x)
18.	4104579 M	Connector
19.	4104582 M	Disc (2x)
20.	4104583 M	Hex Nut (2x)
21.	4104585 M	Shaft
22.	4103348 P	Spring
23.	4104578 M	Bushing (2x)
24.	4102576 P	O-Ring 007 - Neoprene (2x)
25.	4104572 A	Plunger Assembly
26.	4104576 P	O-Ring 021 - Neoprene
27.	4102337 P	Tee
28.	4102720 P	Elbow - Male 1/4 to 1/8 NPT (2x)
29.	4104717 M	ORMc Mount

(continued)

Oxygen Ratio Monitor Controller NM2A

4104000 - A



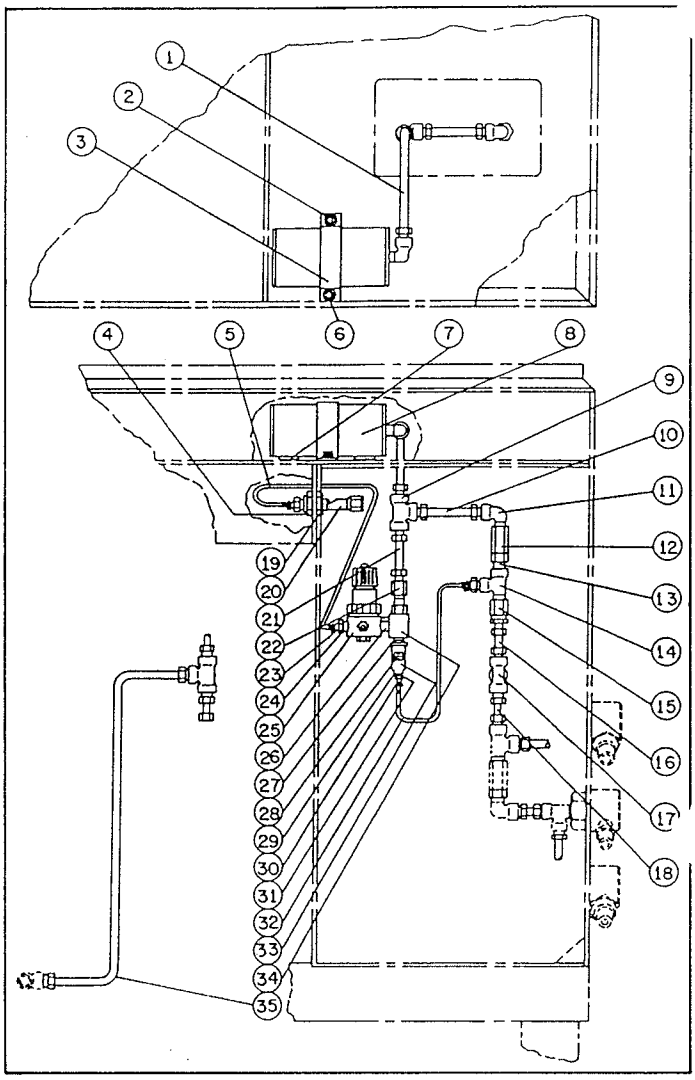
30. 4105738 A Wire Harness ORMc
31. 4105126 P Switch - MPL 8cm H_2O NO
32. 4102164 P Reducer
33. 4105678 M Cam Bracket
34. 4105682 P Spring
35. 4105680 M Switch Mount
36. 4105681 M Cam Lock
37. 4105679 M Cam

Items Not Shown

38. 4104621 P Restrictor N_2O (Blue)
39. 4104622 P Restrictor O_2 (Red)
40. 4103440 T Restrictor Housing (2x)

O_2 Supply Alarm - Whistle NM2A

4106180 - A

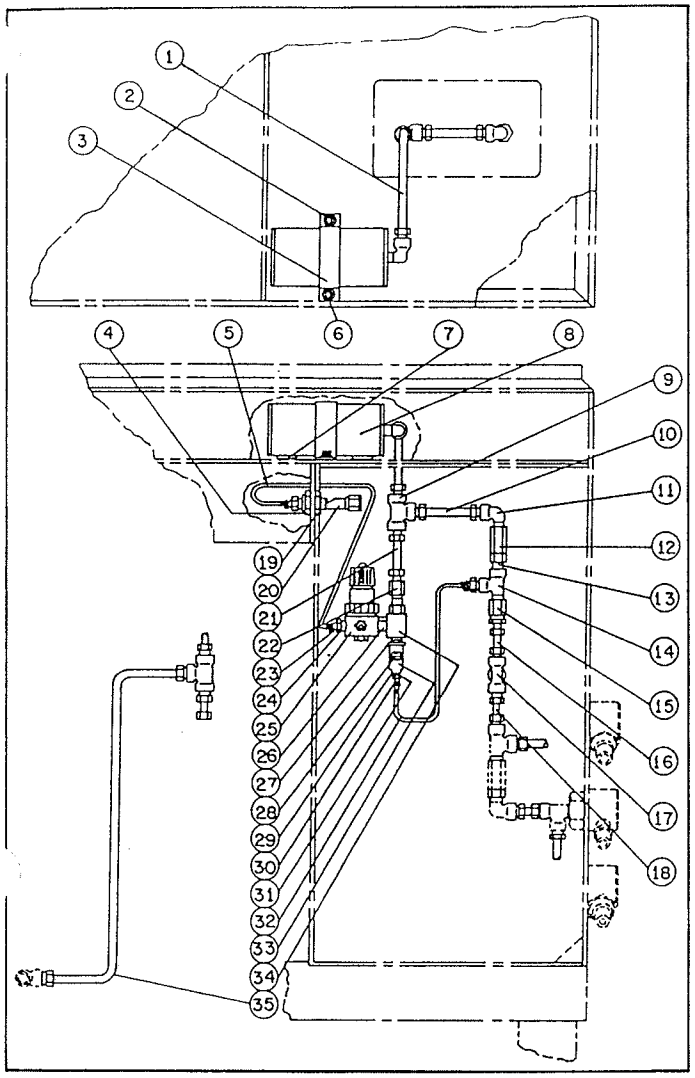


1. 4106208 M Tubing - 1/4 OD Cu
2. 7701023 P Screw - Cap Skt Hd 10-32 x 3/8 L ss (2x)
3. 4106472 P Strap Reservoir
4. 7753000 P Nut - Hex Panel 5/8-16 br
5. 8808003 P Tubing - flex 1/8 OD x .03 (clear)
6. 7765003 P Washer - Lock Split 10 ss (2x)
7. 4106489 P Foam Tape 1-1/2 large (2x)
8. 4106197 A Reservoir Solder Assembly
9. 4102764 P Union Tee - 3 Way 1/4 D
10. 4106209 M Tubing - 1/4 OD Cu
11. 4102720 P Elbow - Male 1/4 D to 1/8 NPT
12. 4105815 P Check Valve
13. 4102784 P Close Nipple 1/8 to 1/8 NPT
14. 4102760 P Tee - 3 Way 1/8 to 1/8 NPT
15. 4102880 P Connector - Female 1/4 NPT to 1/8 NPT
16. 4106211 M Tubing - 1/4 OD Cu
17. 4102764 P Union Tee - 3 Way 1/4 D
18. 4106211 M Tubing - 1/4 OD Cu
19. 4106199 F Feed Thru 1/8 NPT
20. 4106215 A Whistle
21. 4106210 M Tubing - 1/4 OD Cu

(continued)

O_2 Supply Alarm - Whistle NM2A

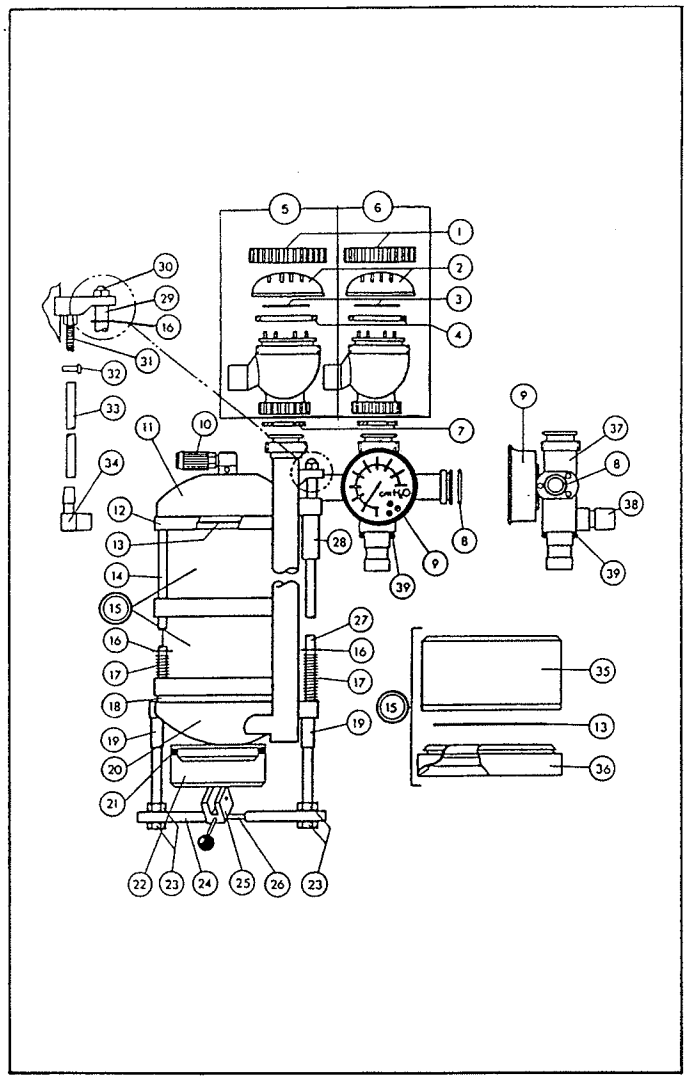
4106180 - A



22.	4102723	P	Connector - Male 1/4 D to 1/8 NPT
23.	4106068	P	Tie Strap (3x)
24.	4106366	P	Fitting 1/8 NPT 1/16 Hose Barb (3x)
25.	4102089	P	Regulator
26.	4102784	P	Close Nipple 1/8 NPT to 1/8 NPT
27.			Lock Nut Supplied with 4106218
28.	4106217	P	Spring replaces existing spring
29.	4102165	P	Washer - Neoprene
30.	4104161	P	Hose Clamp
31.	4103445	P	Straight Fitting
32.	8808003	P	Tubing - flex 1/8 OD x .03 (clear)
33.	4104882	P	Valve - Actuator
34.	4106218	P	Valve
35.	4106100	M	Tubing - 1/4 OD Cu

Absorber System Sub-Assembly

1101361 - A

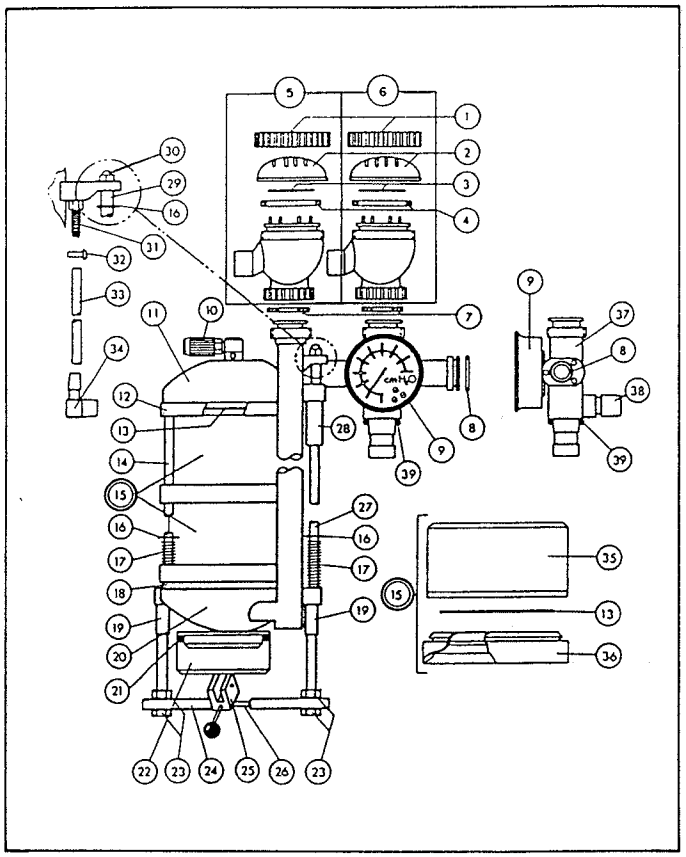


1.	2109228	F	Adapter - Ring Nut
2.	S2122171	P	Plastic Valve Dome (2x)
3.	S7264360	P	Valve Disc (2x)
4.	S2109231	P	Gasket (2x)
5.	2122810	P	Valve Assembly - inspiration
6.	2122812	P	Valve Assembly - expiration
7.	1101690	P	Washer
8.	4102941	P	O-Ring 117 - Neoprene
9.	1101078	P	Pressure Gauge cm H_2O
10.	4102148	A	Connector - In-Circuit
11.	1101351	F	Absorber Top Assembly
12.	4105848	P	Top Gasket
13.	1100022	P	Screen (3x)
14.	1101356	M	Rod 2 - left
15.	4105851	A	Canister Assembly
16.	1100097	P	Spring Clip (3x)
17.	1100094	P	Spring (2x)
18.	1101001	P	Bottom Gasket
19.	1101035	T	Rod Bushing (2x)
20.	1101344	F	Bottom Sub-Assembly
21.	4102940	P	O-Ring Dust Cap Assembly

(continued)

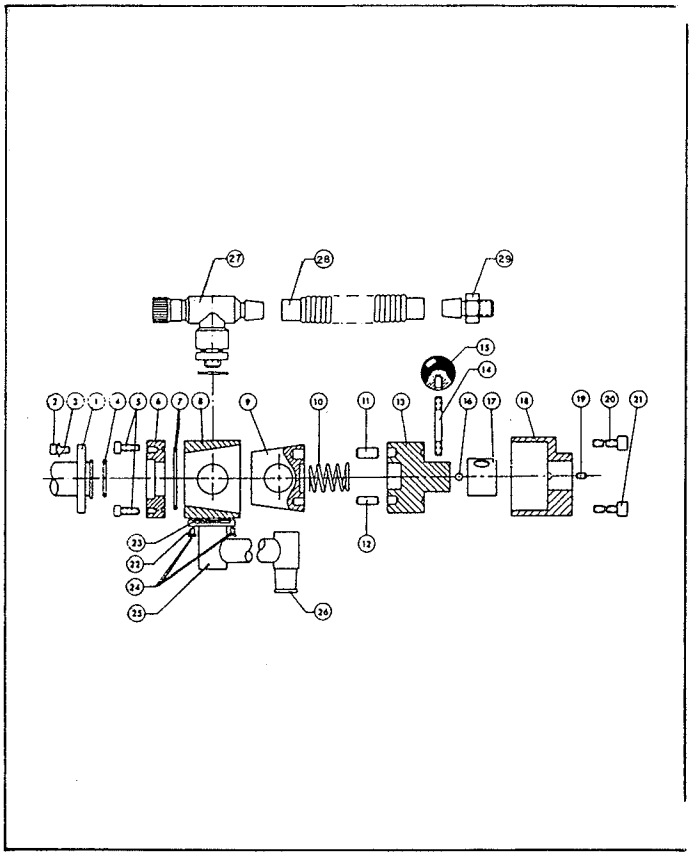
Absorber System Sub-Assembly

1101361 - A



Manual/Automatic Selector Valve

4102698 - A

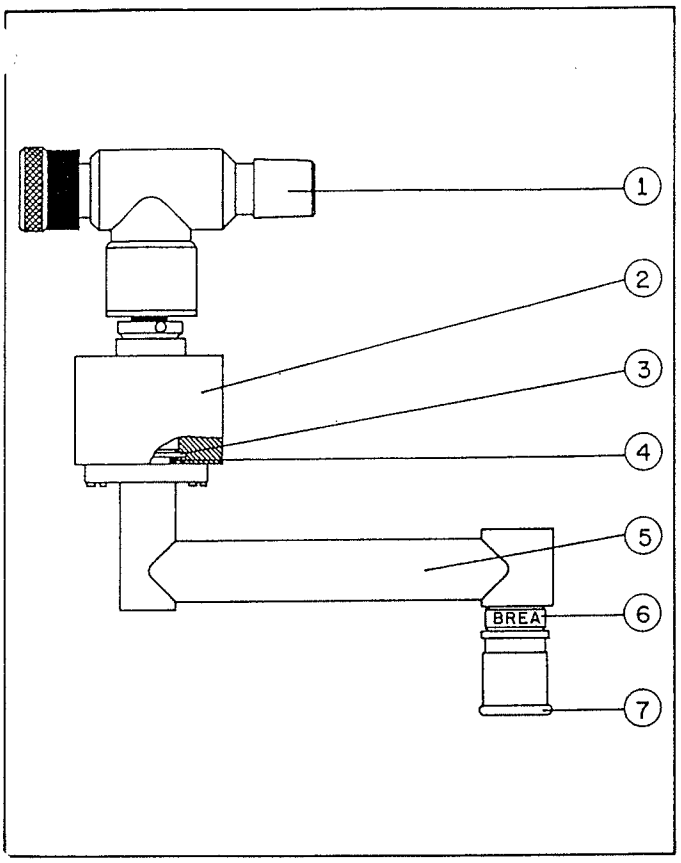


22.	4106874	P	Dust Cap Assembly
23.	7750010	P	Nut - Hex 3/8-16 ss (4x)
24.	1101018	F	Cam Bar (2x)
25.	1101015	A	Cam Assembly Complete
26.	1101017	M	Connecting Pin
27.	1101355	M	Rod 1 - right
28.	1101023	F	Bushing
29.	1101022	M	Guide Pin
30.	7751002	P	Nut - Acorn 3/8-16 ss
31.	4103336	F	Straight Fitting 1/8 NPT
32.	1101732	P	Cable Tie
33.	4103982	P	Tubing - Fresh Gas 30 inch
34.	4102054	F	Connector - 15mm
35.	4105852	P	Canister Tube (2x)
36.	4105849	P	Canister Gasket (2x)
37.	4106730	F	Valve & Gauge Block Solder Assembly
38.	4106642	F	Connector - 19mm
39.	4102021	P	O-Ring 020 - Neoprene
			Items Not Shown
40.	1101724	F	Pole Assembly
41.	7704016	P	Screw - Set Cup Pt 3/8-16 x 3/8 L ss

1.	1101351	F	Absorber Top Assembly Reference
2.	7701012	P	Screw - Cap Skt Hd 8-32 x 3/8 L ss (3x)
3.	7765002	P	Washer - Lock Split 8 (3x)
4.	4102941	M	O-Ring 117 - Neoprene
5.	7701014	P	Screw - Cap Skt Hd 8-32 x 1/2 L ss (4x)
6.	4102694	F	Adapter Flange - Black Aluminum
7.	4105767	P	O-Ring 222 - Silicone
8.	4102734	F	Valve Housing
9.	4102692	M	Valve Channel - Delran
10.	4102693	P	Spring
11.	4102701	P	Dowel Pin
12.	4102702	P	Dowel Pin
13.	4102700	A	Valve Switch Assembly
14.	1101011	M	Stem
15.	4101848	P	Ball - Black Plastic
16.	1101637	P	Ball Bearing ss (2x)
17.	4103118	F	Cover
18.	4102691	F	Valve Switch Block
19.	7704014	P	Screw - Cup Pt Skt Hd 1/4-28 x 1/4 L ss (2x)
20.	7701019	P	Screw - Cap Skt Hd 8-32 x 1 1/4 L ss (2x)
21.	7701020	P	Screw - Cap Skt Hd 8-32 x 1 1/2 L ss (2x)
22.	1101335	P	Glide Ring - Teflon
23.	4105868	P	O-Ring 020 - Silicon
24.	7702015	P	Screw - Pan Hd Sltd 8-32 x 3/8 L ss (4x)
25.	1101334	F	Swivel Bag Mount Assembly
26.	4102894	F	Bag Connector - Black Nylon
27.	4104839	P	APL Relief Valve
28.	4104777	P	Scavenging Tube 19mm 10 inch
29.	4106642	F	Connector - 19mm

Absorber Bag Mount and Relief Valve Assembly

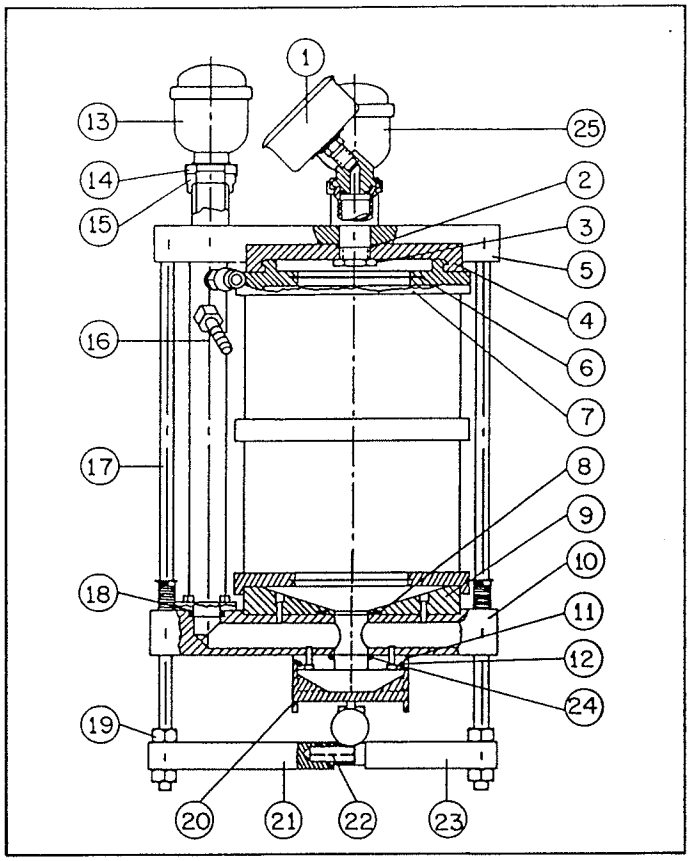
1101580 - A



1. 4104839 P APL Relief Valve
2. 1101581 F Mount Solder Assembly
3. 1101335 P Glide Ring
4. 4105868 P O-Ring 020 - Silicon
5. 1101334 F Swivel Bag Mount Assembly
6. 1100561 P Breathing Bag Label
7. 4102894 F Bag Connector

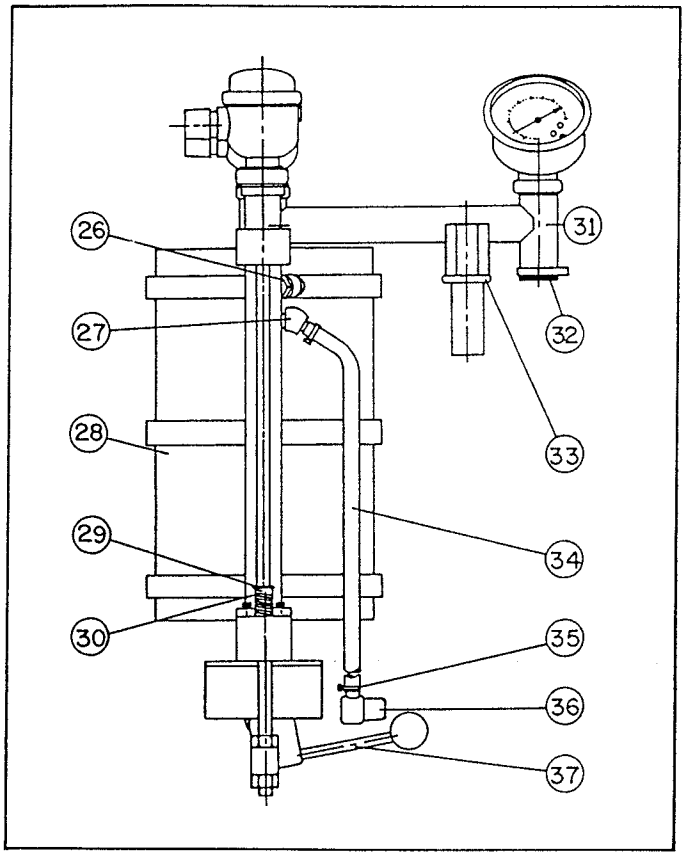
Autoclavable Absorber

4105500 - A



1. 4105853 A Gauge Assembly
2. 4105867 P O-Ring 118 - Silicone
3. 4105841 F Nut
4. 4105837 M Top Absorber Housing
5. 4105840 M Absorber Top Mount
6. 1100022 P Canister Screen
7. 4105848 P Gasket
8. 4105839 P O-Ring 027 - Silicone
9. 4105838 M Bottom Absorber Housing
10. 4105844 A Absorber Bottom Mount Assembly
11. 4106844 M Dust Cap Adapter
12. 4106889 P O-Ring 149 - Silicone
13. 2122810 P Valve Assembly - inspiratory
14. 1101690 P Gasket
15. 4105855 F Valve Mount - inspiratory
16. 4105832 F Adapter Tube Assembly
17. 4105843 M Absorber Rod (2x)
18. 4105766 P O-Ring 117 - Silicone
19. 7750010 P Nut - Hex 3/8-16 ss (4x)
20. 4106874 P Dust Cap
21. 4105846 F Cam Bar - long
22. 1101017 M Connecting Pin
23. 4105845 F Cam Bar - short
24. 4105866 P O-Ring 120 - Silicone
25. 2122812 P Valve Assembly - expiratory

Autoclavable Absorber
4105500 - A

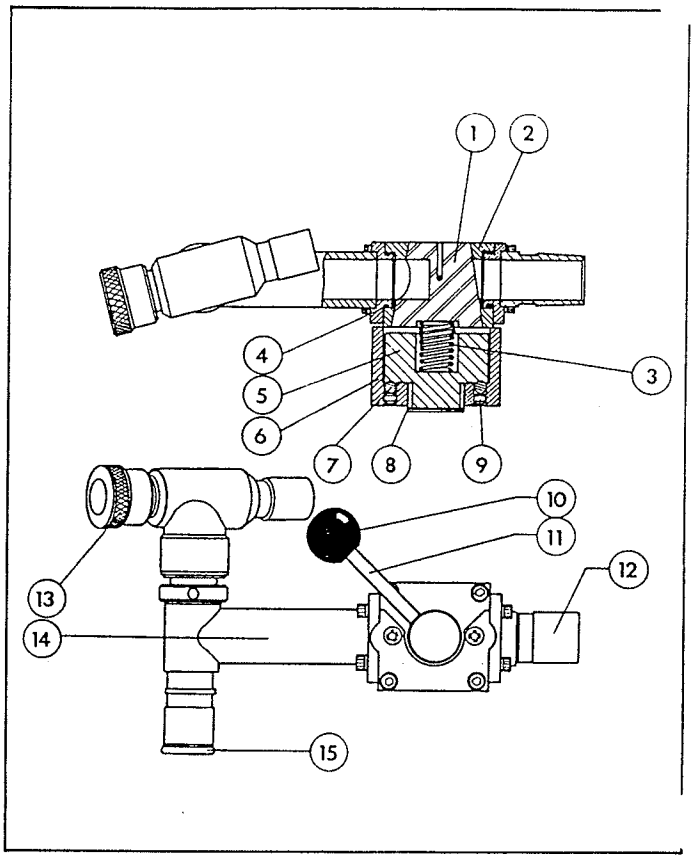


26. 4105307 P Connector - Quick Disconnect
27. 1101670 F Elbow
28. 4105851 A Canister Assembly (2x)
29. 1100097 P Clip (2x)
30. 4105865 P Spring (2x)
31. 4105824 F Tube Assembly
32. 4102941 P O-Ring 117 - Neoprene
33. 4105868 P O-Ring 020 - Silicone
34. 4103982 P Fresh Gas Hose 28 inch
35. 1101732 P Tie Strap (2x)
36. 4102054 F Connector - 15mm
37. 1101015 A Cam Assembly

Items not Shown

38. 4106848 F Plug 3/4-20

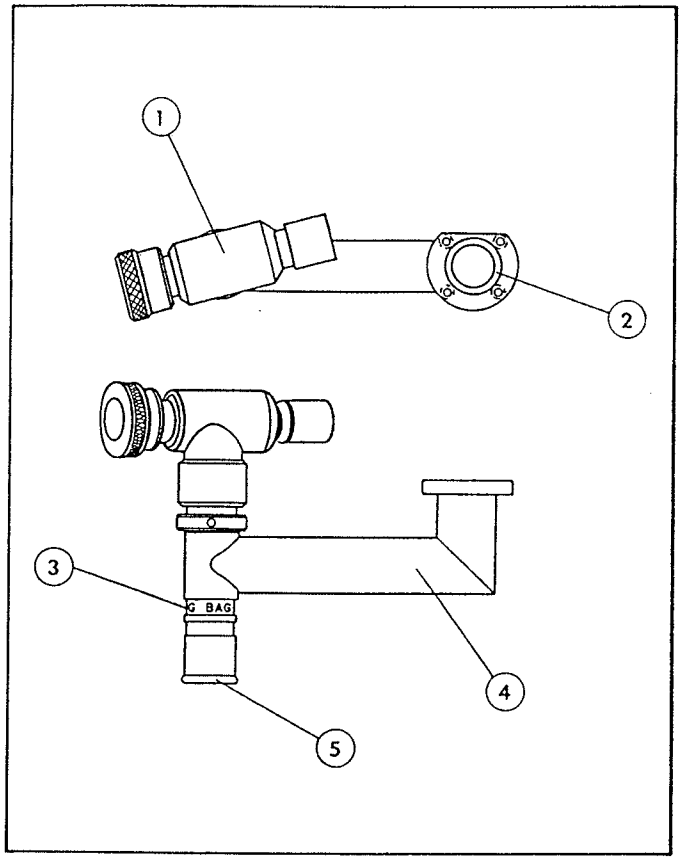
Manual/Automatic Selector Valve (Autoclavable Absorber)
4105812 - A



1. 4105773 M Valve Cone
2. 4105743 F Valve Housing
3. 4102693 P Spring
4. 4105766 P O-Ring 117 - Silicone (2x)
5. 4105994 A Valve Switch Assembly
6. 4102691 F Valve Switch Block
7. 1101637 P Ball Bearing (2x)
8. 4103118 F Cover
9. 7704014 P Screw - Set Cup Pt 1/4-28 x 1/4 L ss (2x)
10. 4101848 P Ball - Black Plastic
11. 1101011 M Stem
12. 4105751 F Vent Adapter Assembly
13. 4104839 P APL Relief Valve
14. 4105761 F Bag Mount Assembly
15. 4102894 F Bag Connector

Bag Mount Assembly (Autoclavable Absorber)

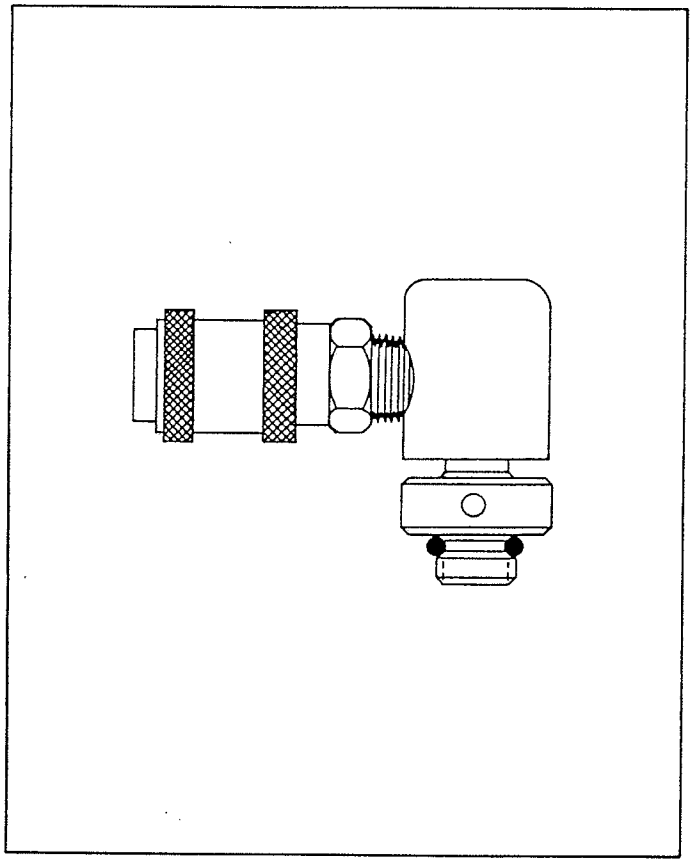
4105807 - A



1. 4104839 P APL Relief Valve
2. 4102941 P O-Ring 117 - Neoprene
3. 1100561 P Breathing Bag Label
4. 4105808 F Bag Mount Assembly
5. 4102894 F Bag Connector

In-Circuit Connector Assembly

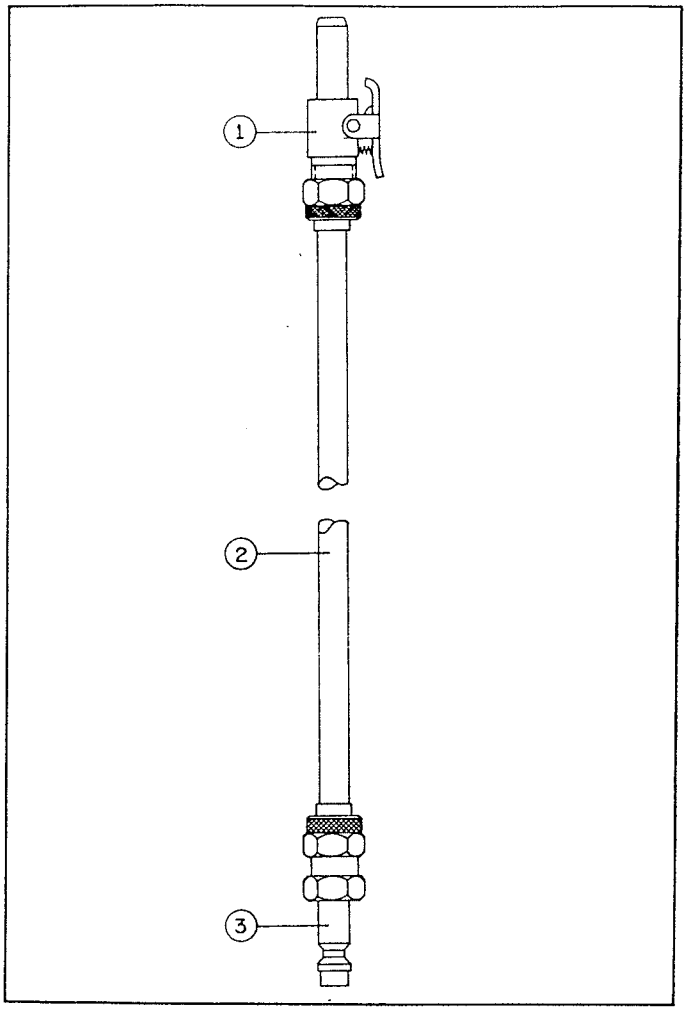
4102148 - A



1. 4102148 A In-Circuit Connector Assembly

Hose Assembly Patient Pressure Alarm

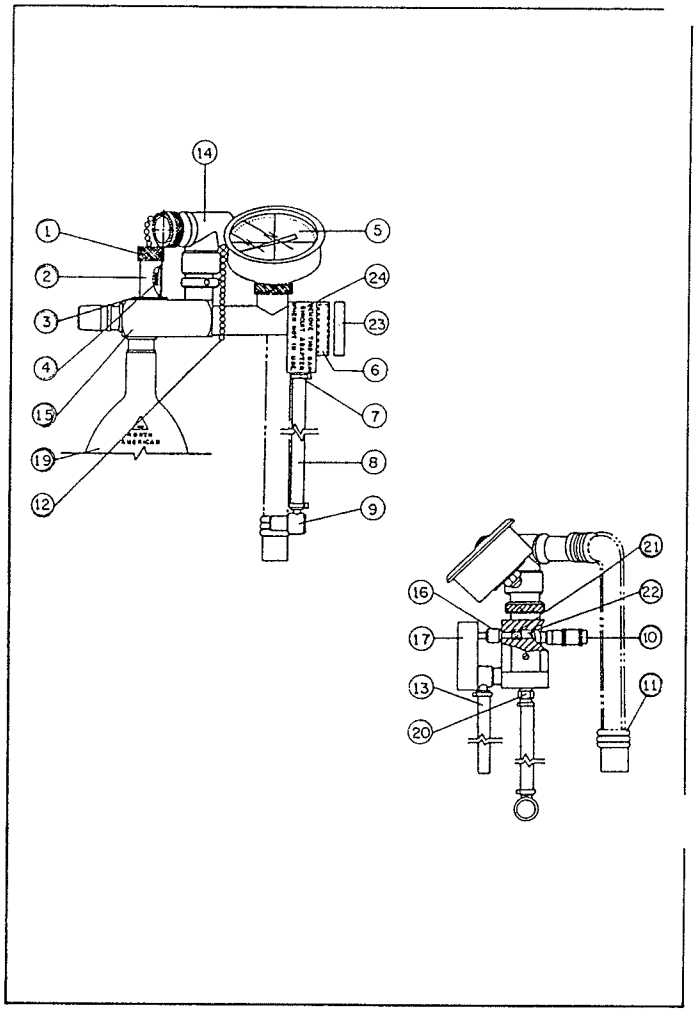
4106541 - A



1. 4103449 P Connector - Male Quick Disconnect
2. 8808002 P Tubing - flex 1/4 D 32 inch (clear)
3. 4105308 P Connector - Male Quick Disconnect

Bain Circuit Module Adapter IL Type O_2 Monitor

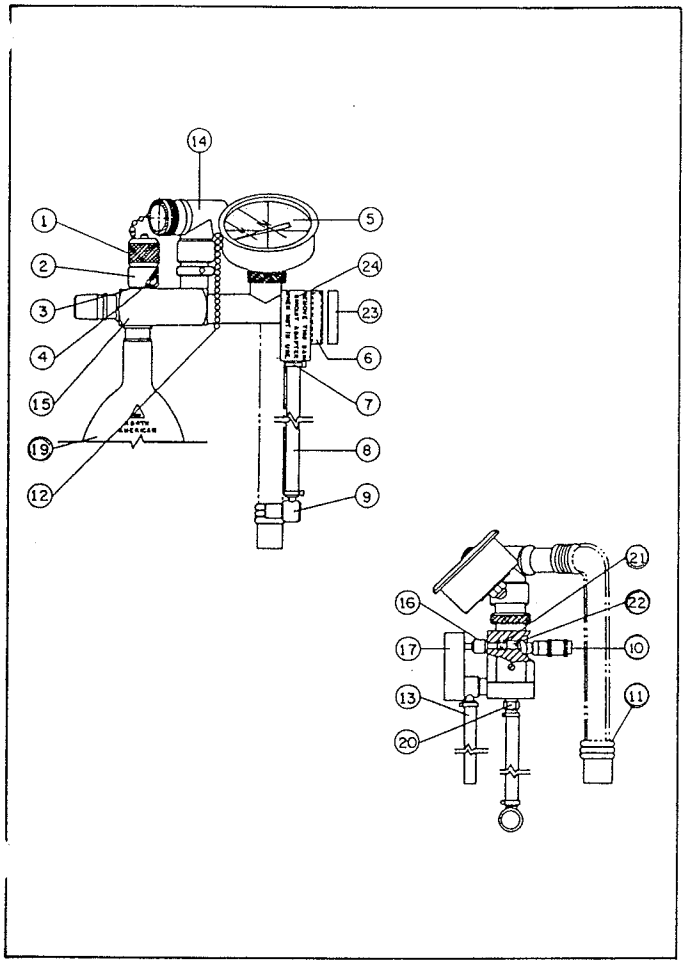
4104525 - A



1. 4106565 A Plug Assembly - IL O_2 Adapter
2. 4104887 M Adapter - IL O_2 Sensor
3. 4102234 P O-Ring 013 - Neoprene
4. 4106070 P O-Ring 012 - Viton
5. 4105853 A Gauge Assembly
6. 4105244 F Bracket - Bain System
7. 4101732 P Tie Strap (3x)
8. 4103982 P Hose - Fresh Gas 28 inch
9. 4102054 F Connector Assembly - Male 15mm (2x)
10. 4105307 P Connector - Quick Disconnect
11. 4104769 A Hose - 19mm x 30 inch corrugated
12. 4103940 P Chain 10 Bead
13. 4103982 P Hose - Fresh Gas 12 inch
14. 4104839 P Relief Valve
15. 4104704 F Bain Adapter
16. 4103712 M Spacer
17. 4103453 F Block
18. 4102894 F Bag Connector
19. 9991872 A Breathing Bag 2 liter
20. 4103336 F Straight Fitting
21. 4103455 P Spring
22. 4103452 M Shaft
23. 4104985 F Mount Bain Circuit
24. 4107097 P Label

Bain Circuit Module Adapter O_2 Monitor

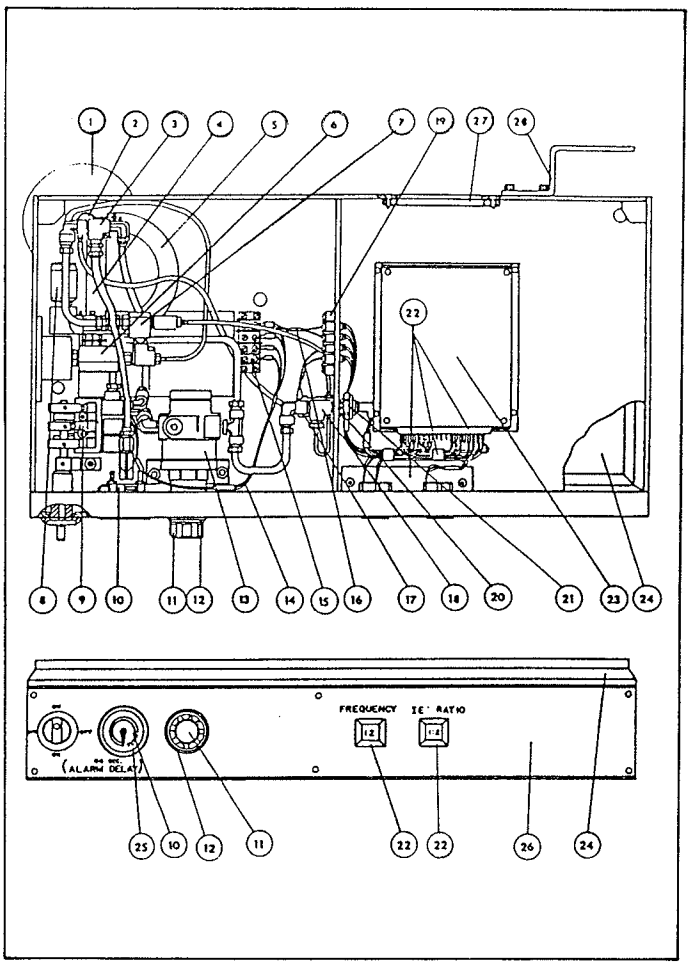
4104533 - A



1.	4106387 A	Plug Assembly - Oxymed Sensor Adapter
2.	4106566 M	Adapter - Oxymed Sensor
3.	4102234 P	O-Ring 013 - Neoprene
4.	4106388 P	O-Ring 016 - Viton
5.	4105853 A	Gauge Assembly - Breathing Pressure
6.	4105244 F	Bracket - Bain System
7.	4101732 P	Tie Strap (3x)
8.	4103982 P	Hose - Fresh Gas 28 inch
9.	4102054 F	Connector Assembly - Male 15mm (2x)
10.	4105307 P	Connector - Quick Disconnect
11.	4104769 A	Hose - 19mm x 30 inch corrugated
12.	4103940 P	Chain 10 Bead
13.	4103982 P	Hose - Fresh Gas 12 inch
14.	4104839 P	Relief Valve
15.	4104704 F	Bain Adapter
16.	4103712 M	Spacer
17.	4103453 F	Block
18.	4102894 F	Bag Connector
19.	9991872 A	Breathing Bag 1 liter
20.	4103336 F	Straight Fitting
21.	4103455 P	Spring
22.	4103452 M	Shaft
23.	4104985 F	Mount Bain Circuit
24.	4107097 P	Label

Ventilator Assembly NM2A

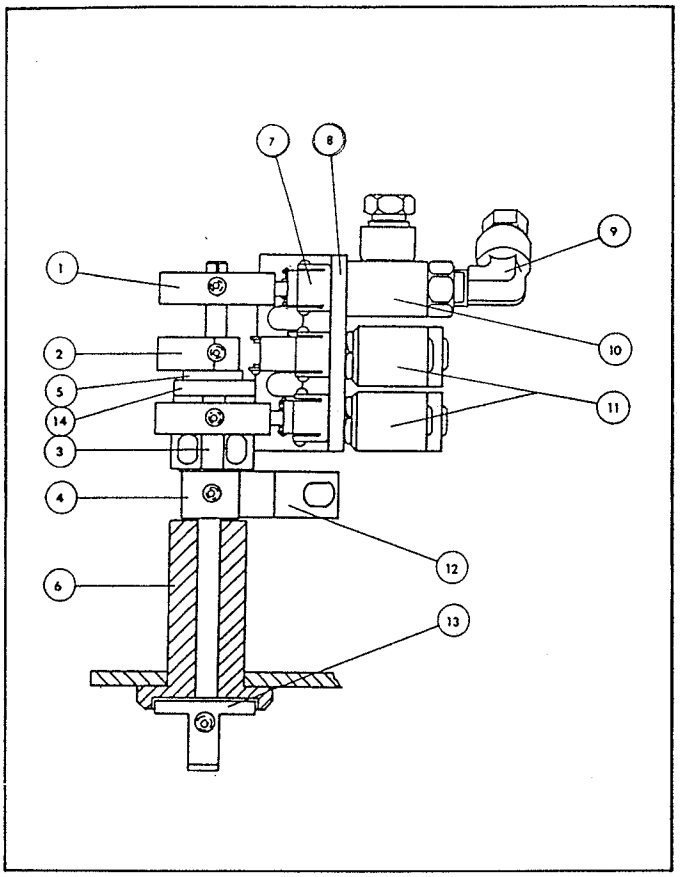
4106032 - A



1.	4106680 A	Muffler Housing Assembly
2.	4106176 A	Exhaust Solder Assembly
3.	4106177 A	Manifold Assembly
4.	4106396 A	Muffler Assembly - internal
5.	8808004 P	Tubing - flex 9 1/4 inch (clear)
6.	4105928 A	Valve Case Assembly
7.	S000207 A	Pneumatic Control Valve Assembly
8.	4106184 A	Pilot Actuator Assembly
9.	4105031 A	Ventilator Switch Assembly
10.	4105032 A	Flow Gauge Assembly
11.	4103394 F	Knob (2x)
12.	4103661 M	Bezel
13.	4105927 A	Flow Regulator Assembly
14.	4106174 A	Wire Harness - Switch Assembly
15.	4106188 P	Terminal Block 4
16.	4106175 A	Wire Harness - Power
17.	4106187 A	Valve - Solenoid Assembly
18.	4102760 M	Tee - 3 Way 1/8 NPT to 1/8 NPT
19.	4105930 P	Terminal Block - Feed Thru
20.	4105063 M	Spacer - Nylon
21.	4103444 P	Pressure Switch
22.	4106033 A	Wire Harness Switch Assembly
23.	4105035 A	Printed Circuit Board & Shield Assembly
24.	4104960 A	Shelf Assembly - Ventilator Box
25.	4103624 M	Gauge Cover
26.	4105919 S	Front Panel
27.	4106903 F	Blind Plate
28.	1101666 A	Hose Bracket

Ventilator Switch Assembly

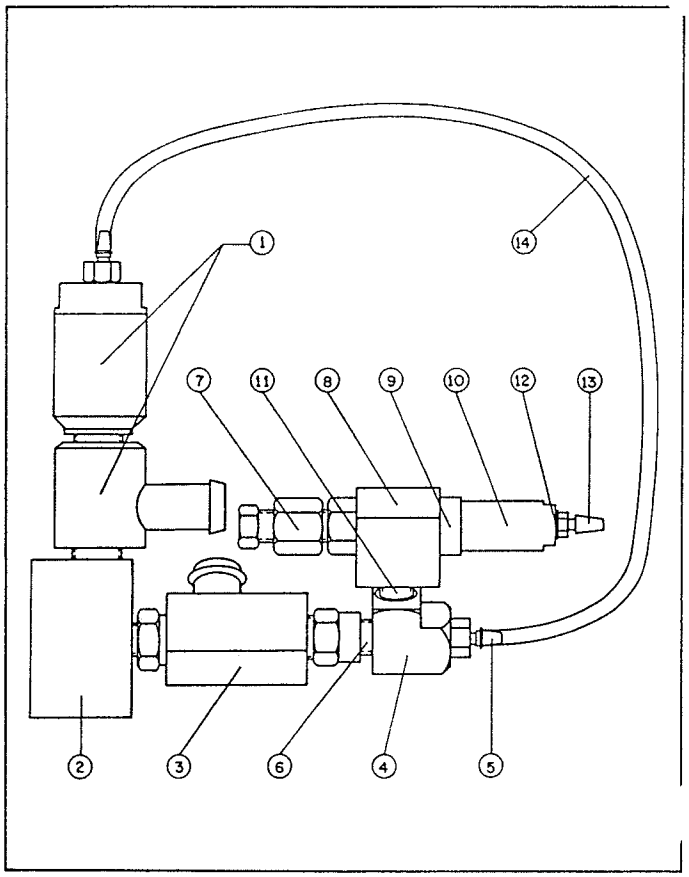
4105031 - A



1. 4103267 M Cam (2x)
2. 4103315 M Cam
3. 4103399 M Shaft
4. 4103401 M Switch Stop
5. 4105282 M Adapter
6. 4104289 M Insert
7. 4103339 P Cam Follower (3x)
8. 4105076 M Bracket Ventilator Switch
9. 4102720 P Elbow - Male 1/4 D x 1/8 NPT (2x)
10. 4103588 P Valve - Clippard
11. 4103341 P Electrical Switch (2x)
12. 1101502 F Valve Spring
13. 4103169 F Knob
14. 4105281 M Switch Mounting Bracket

Valve Case Assembly NM2A

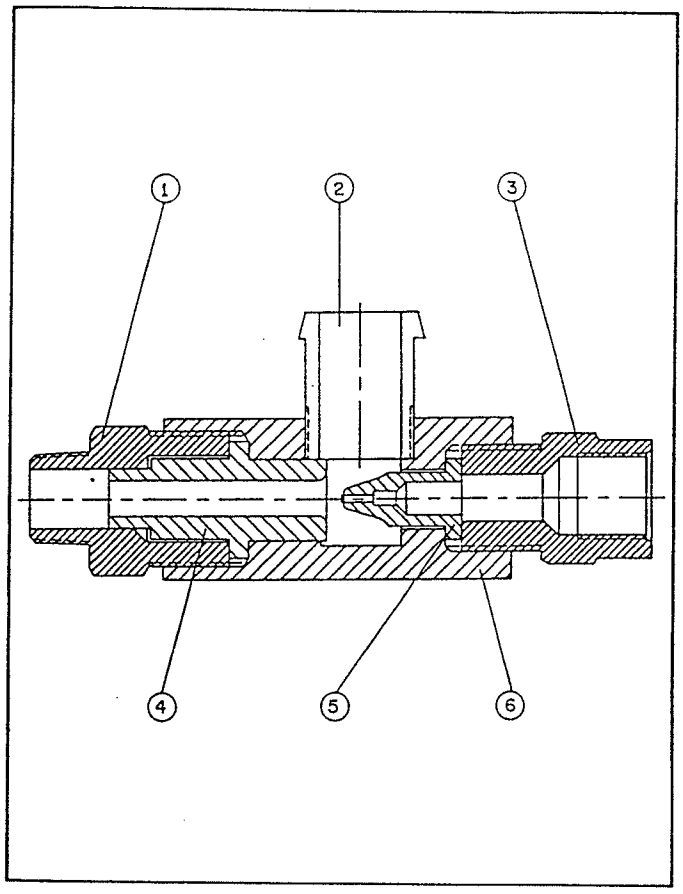
4105928 - A



1. 4106184 A Pilot Actuator Assembly
2. 4106178 M Block
3. 4106179 A Venturi Assembly
4. 4102760 M Tee - 3 Way 1/8 NPT to 1/8 NPT
5. 4106366 P Fitting - 1/8 NPT to 1/16 Hose Barb (2x)
6. 4102784 P Closed Nipple 1/8 NPT to 1/8 NPT
7. 4102723 P Connector - Male 1/4 D to 1/8 NPT
8. 4103340 P Valve - Clippard
9. 4105507 M Washer
10. 4104882 P Valve - Plunger
11. 4102784 P Closed Nipple 1/8 NPT to 1/8 NPT
12. 4102165 P Washer - Neoprene
13. 4103445 P Straight Fitting
14. 8808003 P Tubing - flex 1/8 D (clear)

Venturi Assembly

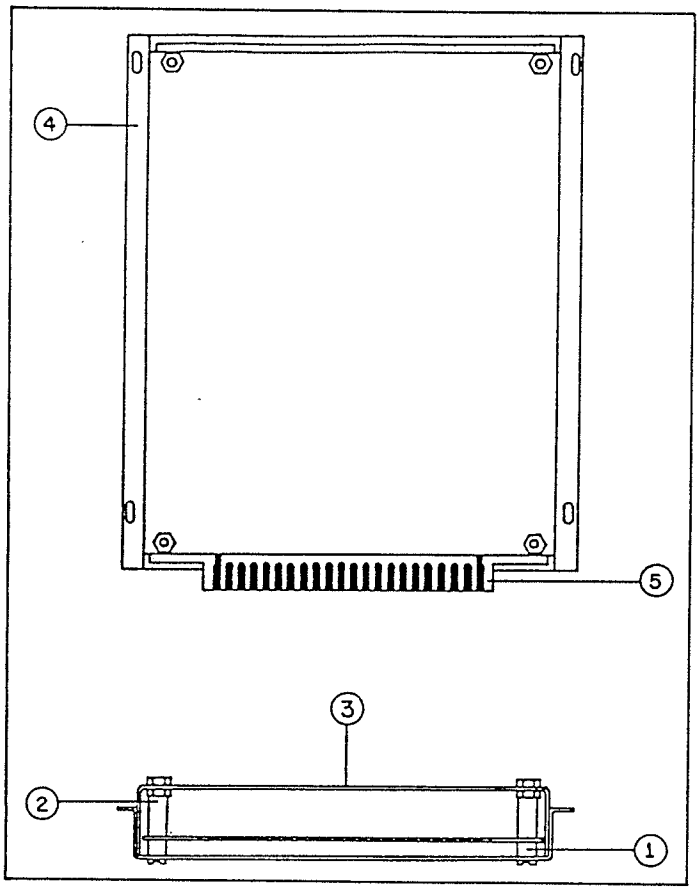
4106179 - A



1. 1101156 M Outlet Adapter
2. 4106234 M Hose Barb
3. 1101154 M Inlet Adapter
4. 1101153 M Mixing Nozzle
5. 1101152 M Nozzle 1
6. 4106233 M Venturi Housing

Printed Circuit Board & Shield Assembly

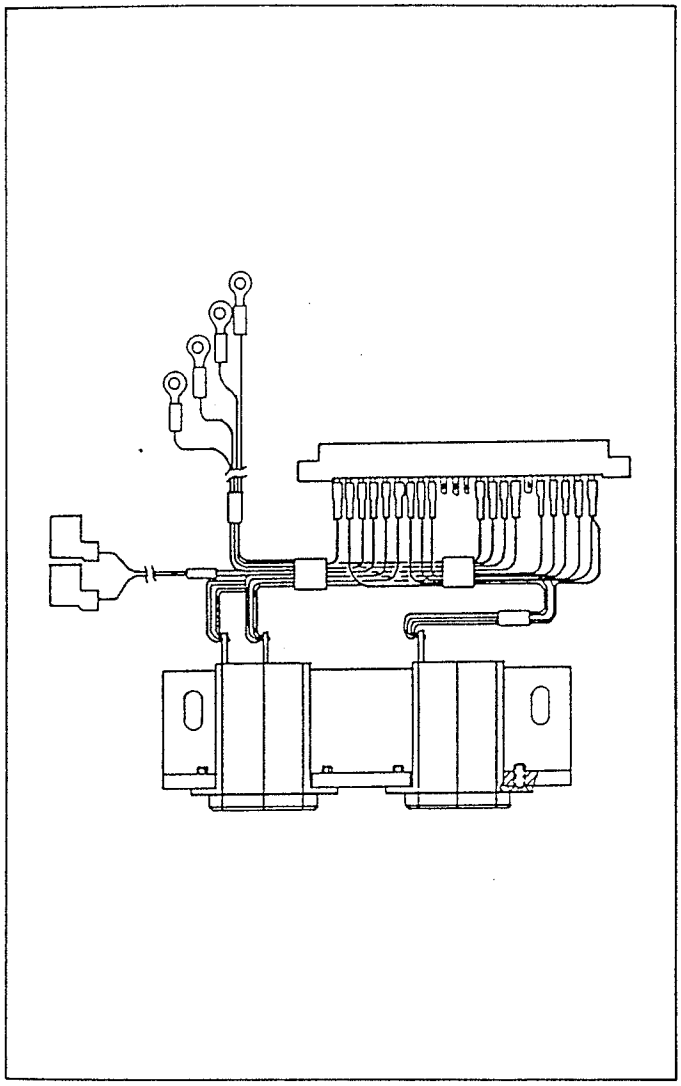
4105035 - A



1. 4106333 P Spacer (4x)
2. 4106907 P Spacer (4x)
3. 4106345 P Shield - upper
4. 4106346 P Shield - lower
5. 4104778 P Printed Circuit Board

Thumbwheel Switch Assembly

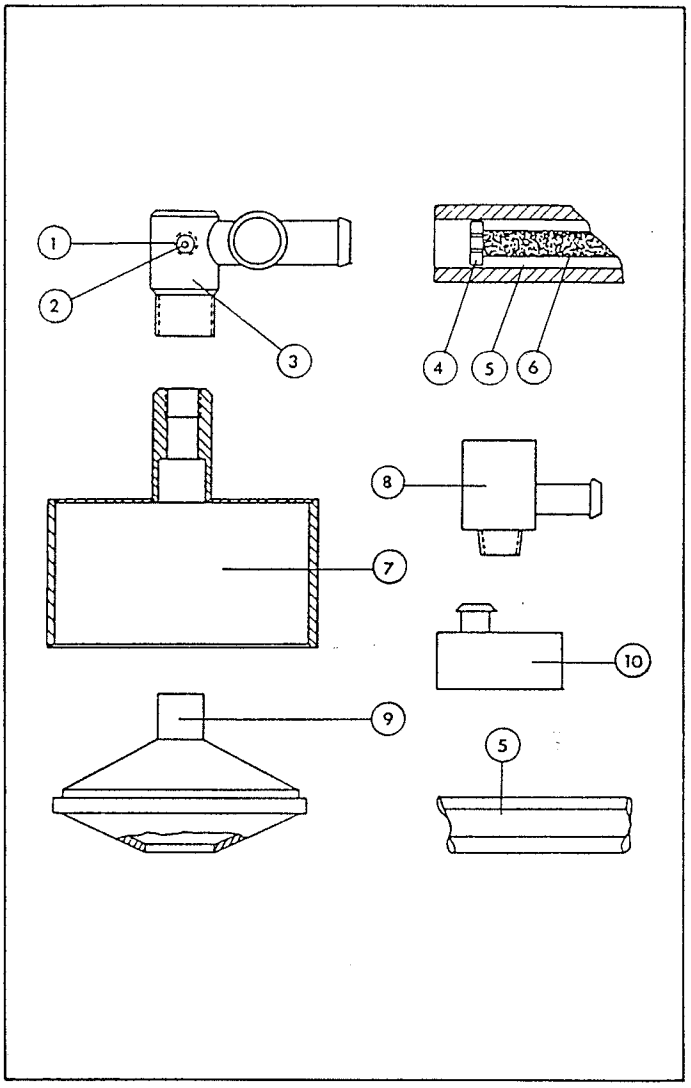
4106033 - A



1. 4106033 A Thumbwheel Switch Assembly

Ventilator Exhaust Assembly

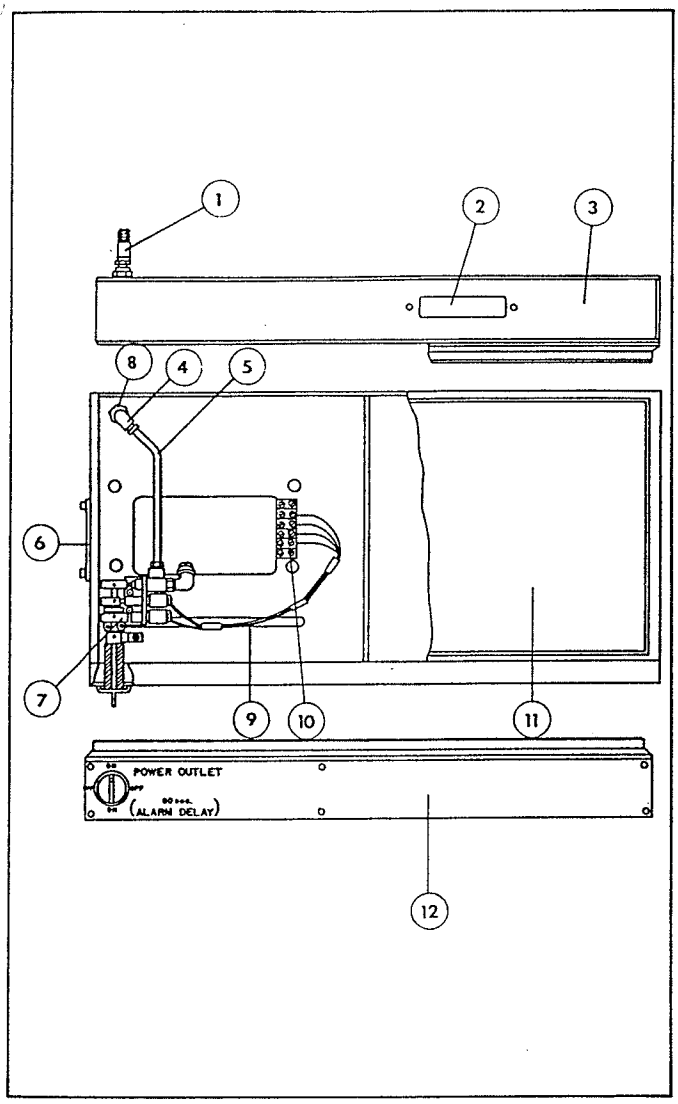
S000208 - A



1. 4102165 P Washer - Neoprene
2. 4103445 P Straight Fitting
3. 4106176 A Exhaust Solder Assembly
4. 4106393 M Muffler Screen - internal (2x)
5. 8808004 P Tubing - flex 1/2 ID (clear)
6. 4106395 P Damper Foam
7. 4106680 A Muffler Housing Assembly
8. 4106181 A Valve Outlet Solder Assembly
9. 4106397 A Muffler Assembly - external
10. 4106179 A Venturi Assembly

Ventilator Blank Assembly NM2A

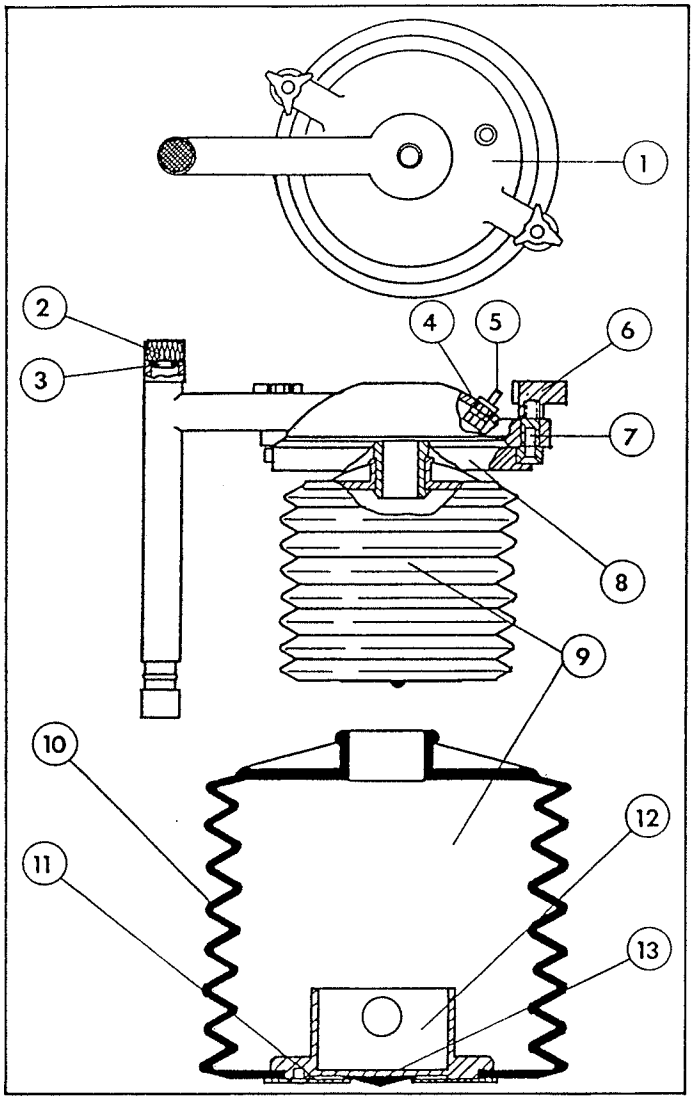
4105316 - A



1.	4104689 P	Connector - DISS O_2 Check Unit
2.	4106903 F	Plate - Blind Cover
3.	4105925 F	Ventilator Box Weld Assembly
4.	4102720 P	Elbow - Male 1/4 D to 1/8 NPT
5.	4106194 M	Tubing - 124 Cu
6.	4104425 F	Plug
7.	4105031 A	Switch Assembly
8.	4106199 F	Feed Thru 1/8 NPT
9.	4106174 A	Wire Harness - Switch Assembly
10.	4106188 P	Terminal Block 4
11.	4104960 A	Shelf Assembly
12.	4105313 S	Plate - front

Descending Bellows Dome Assembly

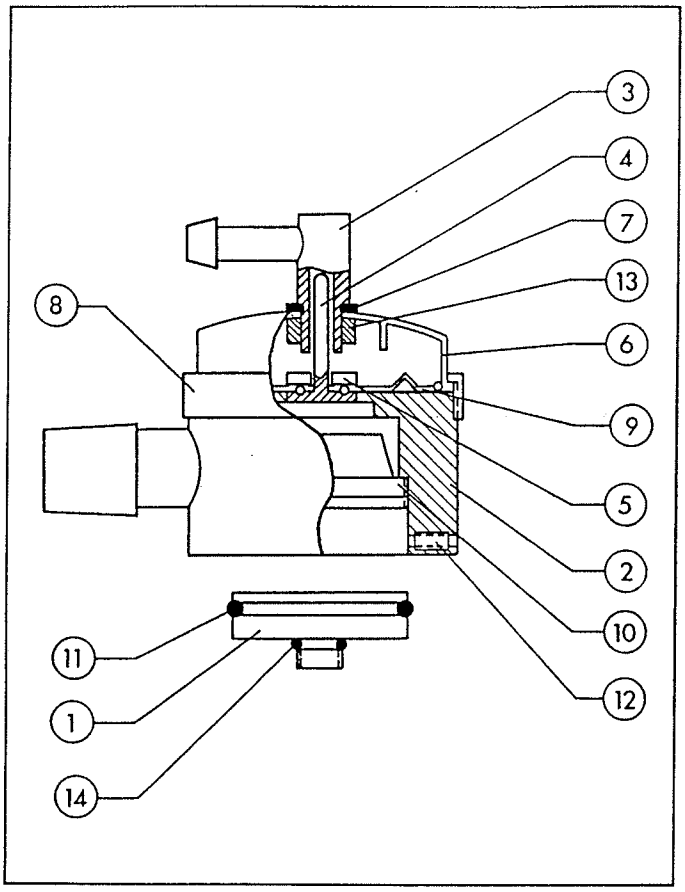
1101295 - A



1.	1101282 F	Top Assembly
2.	4105077 M	Knob
3.	4102193 P	O-Ring 115 - Neoprene
4.	1101780 P	O-Ring 011 - Neoprene
5.	4103208 F	Hose Barb
6.	4105699 P	Wing Nut (2x)
7.	4106232 M	Nut Extension
8.	4105848 P	Top Gasket
9.	4104844 A	Bellows Assembly
10.	2206402 P	Bellows
11.	1101205 F	Plate - outside
12.	4104816 P	Inner Piece
13.	2208135 P	Rubber Stop

Ventilator Relief Valve (Descending Bellows)

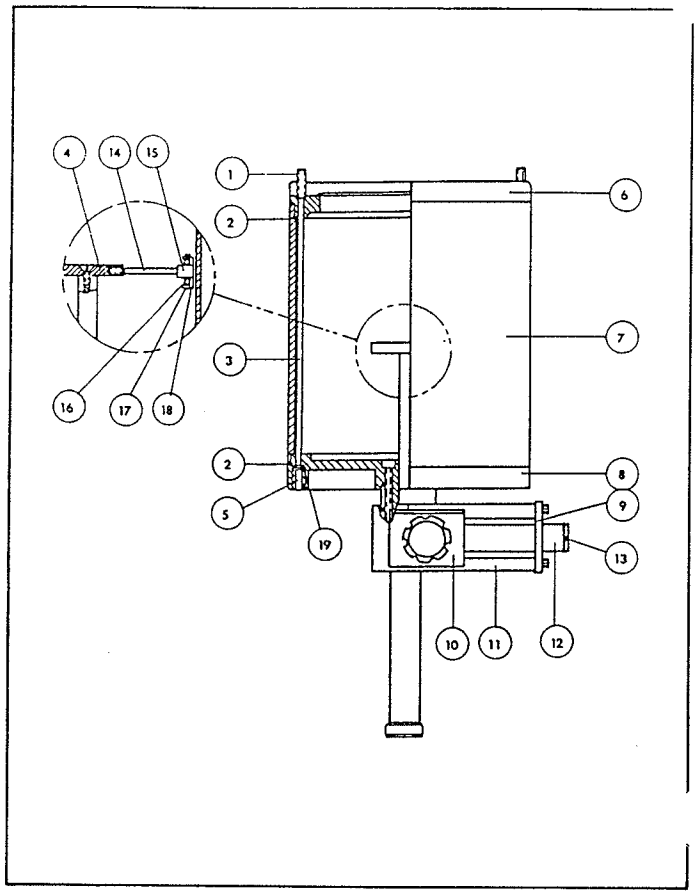
1101371 - A



1. 1101227 F Adapter
2. 1101239 F Valve Housing
3. 1101321 A Elbow Assembly
4. 1101323 M Stop Pole - Nylon
5. 1101324 M Clamp - Nylon
6. 1101373 M Dome
7. 4104503 P Washer - Neoprene
8. 2109228 F Adapter
9. 2121805 P Diaphram
10. 7264277 P A-Valve Assembly
11. 4102944 P O-Ring 124 - Neoprene
12. 7707003 P Screw - Set Cone 6-32 x 1/4 L ss
13. 7750009 P Nut - Hex 5/16-24 ss
14. 1101780 P O-Ring 011 - Neoprene

Descending Bellows Canister Assembly

4106269 - A



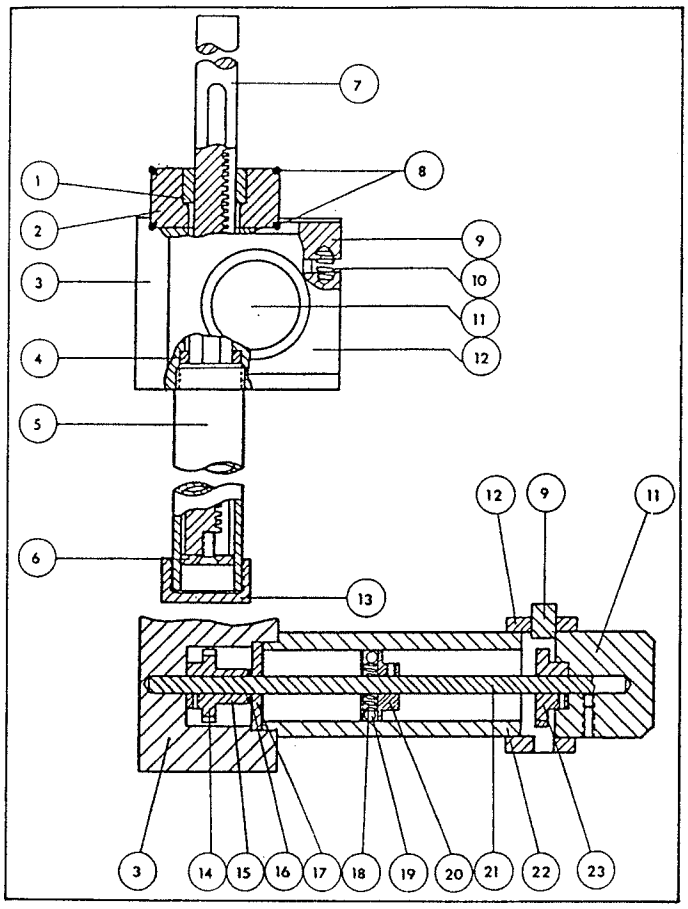
1. 1101208 M Bushing - threaded (2x)
2. 4102615 P O-Ring 264 - Neoprene (2x)
3. 1101409 M Stud Rod (5x)
4. 1101194 F Stop Plate
5. 1101210 M Ring Nut (5x)
6. 1101182 M Top Ring
7. 1101199 S Canister
8. 1101181 M Bottom
9. 4103274 F Support Plate
10. 4104688 A Adjustment Assembly
11. 1101288 F Spacer (4x)
12. 1101545 F Connector
13. 4102336 P O-Ring 018 - Neoprene
14. 4104807 M Stem
15. 4104808 F Block
16. 4104809 M Adjustment Pin
17. 4104810 P E-Ring (2x)
18. 4104811 F Indicator
19. 4101872 P O-Ring 010 - Neoprene (5x)

Items not Shown

20. 4105498 A Hose Bracket Scavenger

Bellows Adjustment Assembly

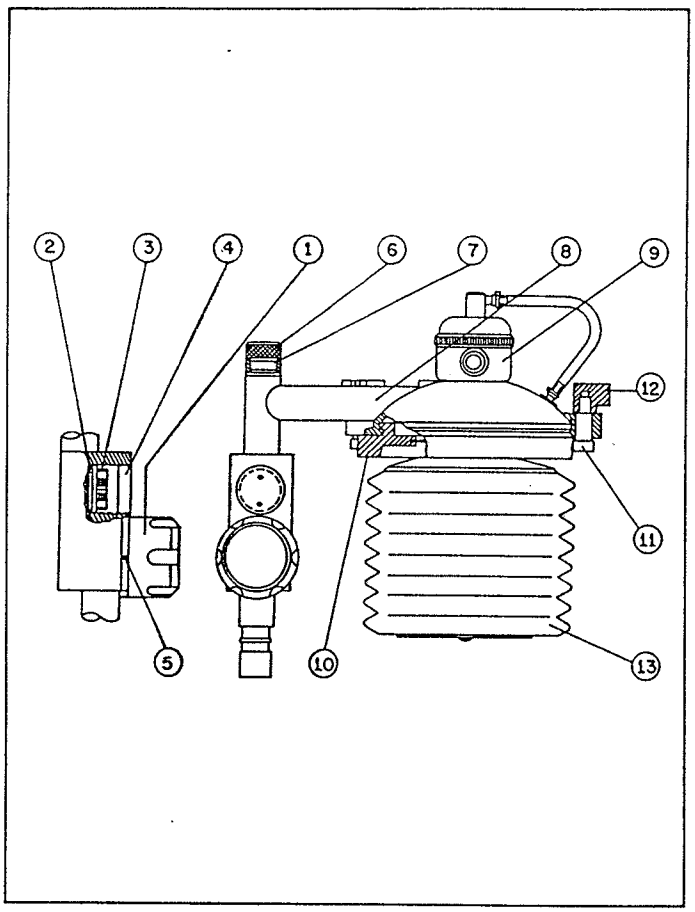
4104688 - A



1. 1101195 M Guide Ring
2. 1101179 F Connection Piece
3. 1101203 F Block
4. 1101294 M Guide Ring
5. 1101193 F Tube
6. 1101426 M Stop
7. 1101196 F Adjustable Rod
8. 4102616 P O-Ring 131 - Neoprene (2x)
9. 4104488 F Rack Solder Assembly
10. 4102966 P Spring (2x)
11. 4104449 F Knob
12. 4104444 F Block
13. 1101192 F Cap
14. 1101412 M Gear
15. 1101307 M Gasket
16. 4101872 P O-Ring 010 - Neoprene
17. 1101189 M Gasket
18. 4103049 P Spring - short (4x)
19. 4103048 P Ball Bearing (4x)
20. 4104712 M Bushing - friction
21. 4104687 M Shaft
22. 4104447 F Tube
23. 1101412 M Gear

Descending Bellows Peep Assembly

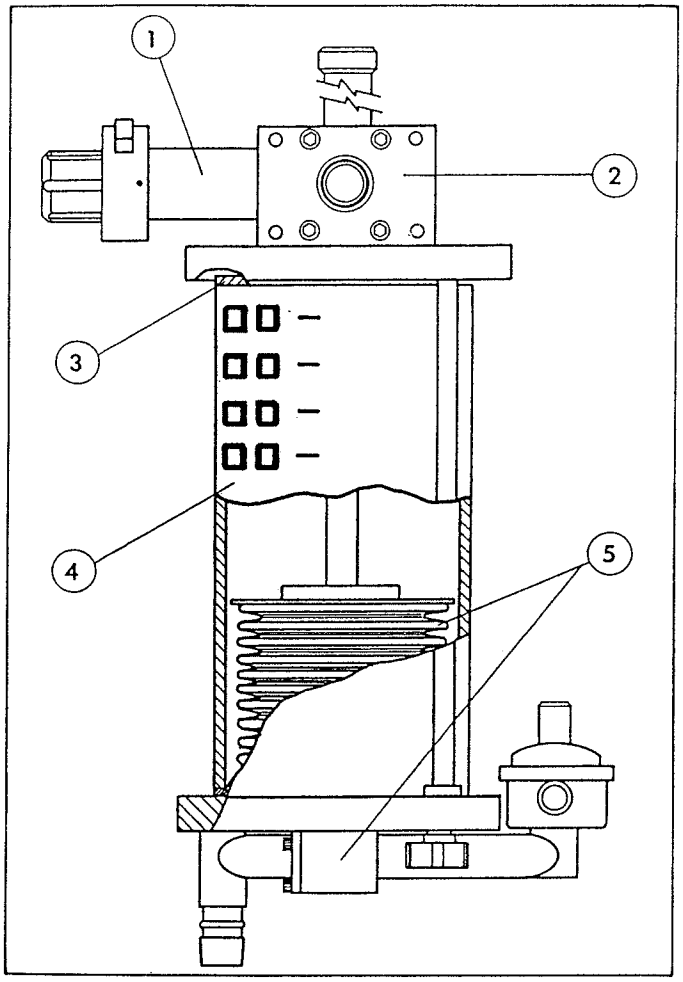
4106270 - A



1. 4106273 A Valve Assembly - peep w/ knob
2. 4101912 P O-Ring 216 - Neoprene
3. 7264277 P A-Valve
4. 4106291 F Plug
5. 4106709 M Set Screw Modified (2x)
6. 4105077 M Knob
7. 4102193 P O-Ring 115 - Neoprene
8. 4106272 F Body - Peep Valve Assembly
9. 4106030 A Relief Valve Assembly
10. 4105848 P Gasket
11. 4106232 M Nut - extension (2x)
12. 4105699 P Wing Nut (2x)
13. 4104844 A Bellows Assembly

Ascending Bellows Assembly

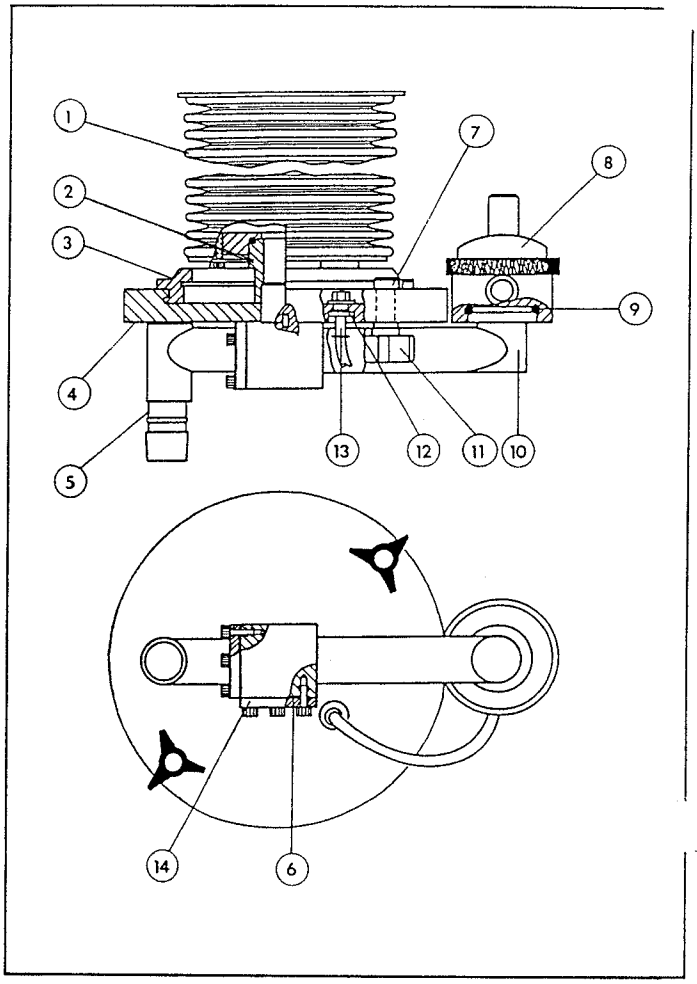
4106000 - A



1. 4105620 A Lock Adjustment Assembly
2. 4106026 A Adjustment Assembly
3. 1100024 P Gasket
4. 4105697 S Canister
5. 4106067 A Bellows Assembly

Ascending Bellows Bottom Assembly

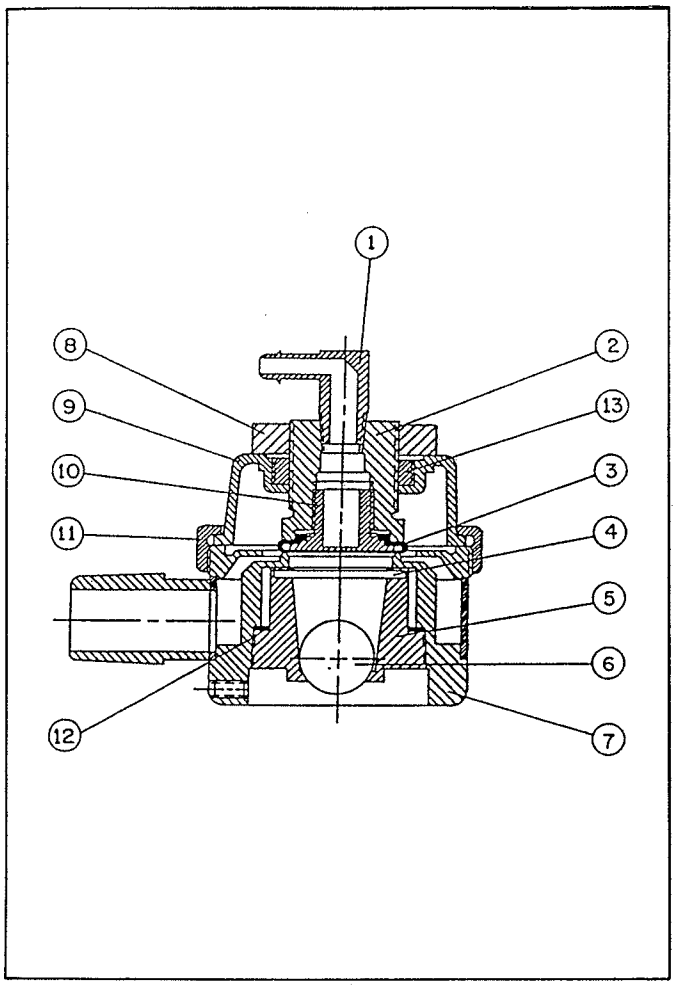
4106067 - A



1. 4106129 A Bellows Sub-Assembly
2. 4105709 F Bellows Adapter
3. 1100017 P Gasket
4. 4105715 M Bellows Plate
5. 4106446 F Connector Assembly - 22mm
6. 4106458 P O-Ring 019 - Neoprene (2x)
7. 4106135 P Wing Nut Stem (2x)
8. 4106030 A Relief Valve Assembly
9. 4102944 P O-Ring 124 - Neoprene
10. 4105694 F Adapter Assembly
11. 4105699 P Wing Nut (2x)
12. 1101780 P O-Ring 011 - Neoprene
13. 4103208 F Hose Barb
14. 4106451 F Plate Cover (2x)

Ventilator Relief Valve, Ascending Bellows

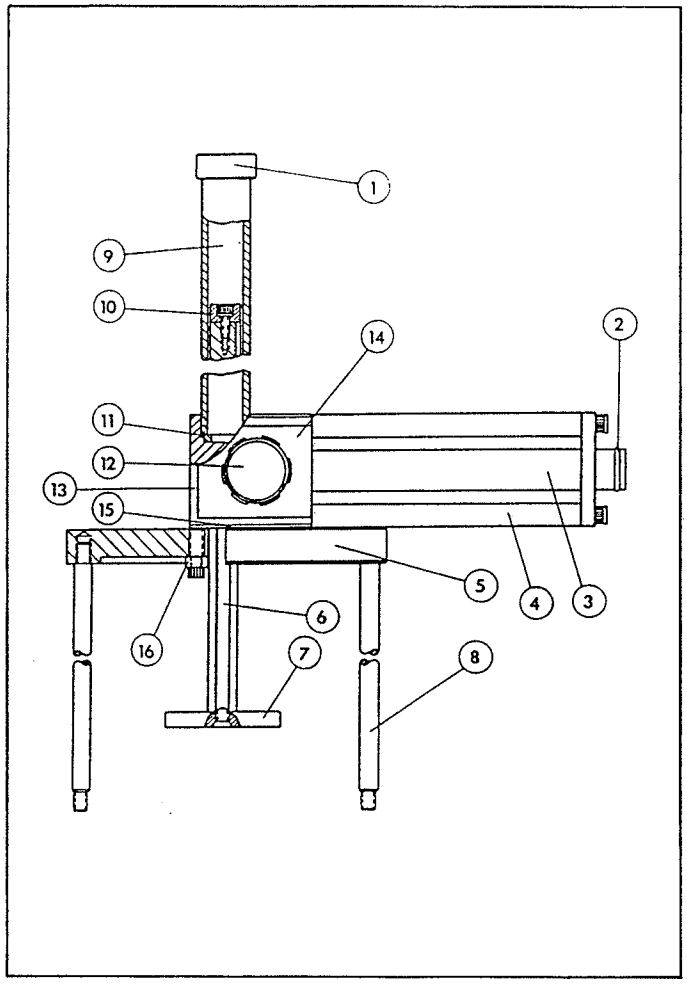
4106030 - A



1.	4106881 F	Elbow - 1/8 NPT
2.	4106884 F	Valve Housing
3.	4106887 P	Diaphragm
4.	4106028 P	Pin
5.	4106027 M	Valve Seat
6.	4106029 P	Ball
7.	1101239 F	Valve Housing
8.	4106883 F	Lock Ring
9.	4106888 A	Cap Assembly
10.	4106882 M	Mount
11.	2109228 F	Adapter Ring
12.	4106321 M	Seal
13.	4106885 M	Insert

Adjustment Assembly Ascending Bellows

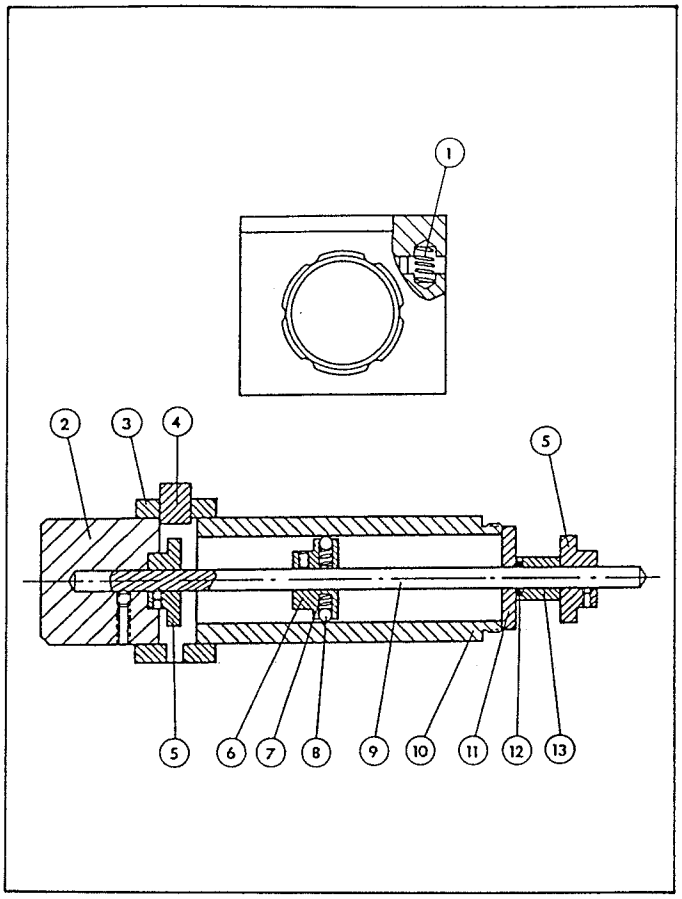
4106026 - A



1.	1101192 F	Cap
2.	4102336 P	O-Ring 018 - Neoprene
3.	4105979 F	Connector
4.	4105977 F	Spacer - Aluminum (4x)
5.	4105980 M	Top Plate
6.	1101196 F	Adjustable Rod Assembly
7.	1101194 F	Stop Plate
8.	4105710 M	Canister Rod (2x)
9.	4105978 F	Tube
10.	4106427 M	Guide
11.	1101294 M	Guide Ring
12.	4104449 F	Knob
13.	4105955 F	Bellows Block
14.	4105620 A	Backing Adjustment Assembly
15.	4106426 P	Gasket
16.	4106425 P	Spacer - Nylon

Locking Adjustment Assembly

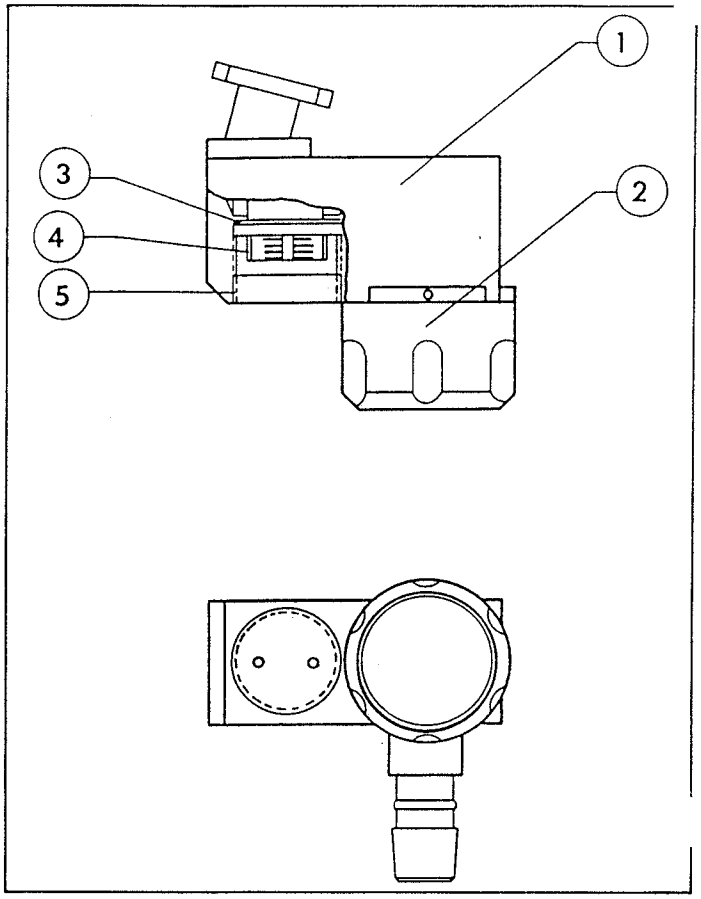
4105620 - A



1. 4102966 P Spring (2x)
2. 4104449 F Knob
3. 4104444 F Block
4. 4104488 F Rack Solder Assembly
5. 1101412 M Gear (2x)
6. 4104712 M Bushing - friction
7. 4103049 P Spring - short (4x)
8. 4103048 P Ball Bearing (4x)
9. 4104687 M Shaft
10. 4104447 F Tube
11. 1101189 M Gasket
12. 4101872 P O-Ring 010 - Neoprene
13. 1101307 M Gasket

Peep Valve Assembly Ascending Bellows

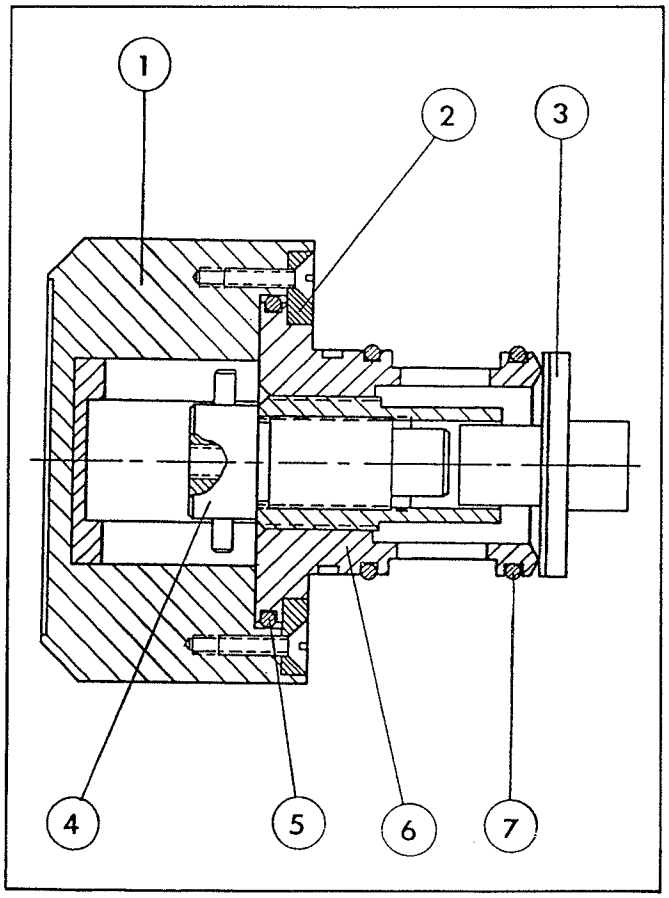
4106350 - A



1. 4106452 F Body - Peep Valve
2. 4106273 A Valve Assembly - peep w/ knob
3. 4106321 M Seal
4. 7264277 P A-Valve
5. 4106291 F Plug

Valve Assembly - Peep with Knob

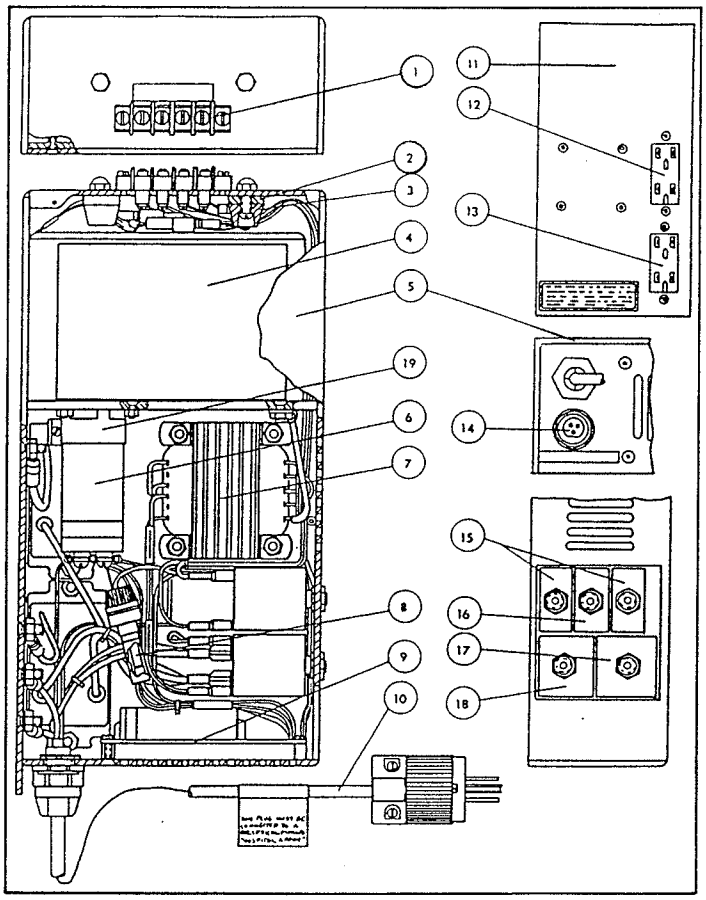
4106273 - A



1. 4106274 A Knob Assembly
2. 4106289 M Retaining Ring
3. 4106276 A Housing Magnet & Seal Assembly
4. 4106277 A Driver & Magnet Assembly
5. 4102944 P O-Ring 130 - Neoprene
6. 4106275 A Housing & Insert Assembly
7. 4102479 P O-Ring 121 - Neoprene

Power Supply Assembly NM2A

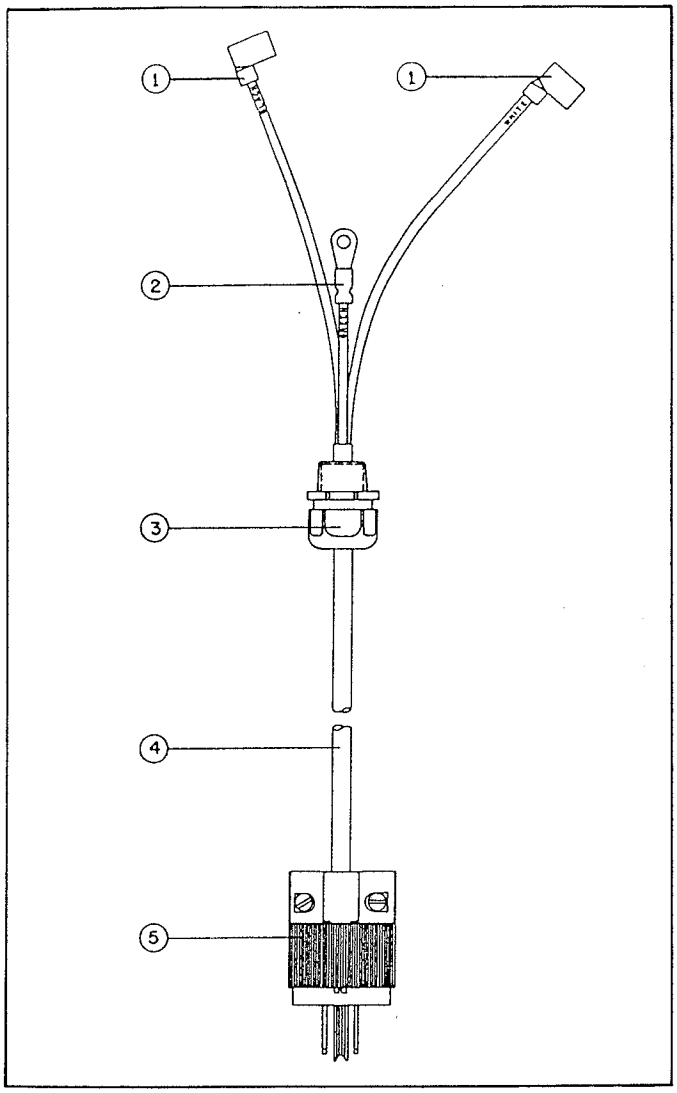
4106102 - A



1. 4105930 P Terminal Block - Feed Thru
2. 4106248 P Spacer (2x)
3. 1101752 P Bumper - 3/4 White Rubber
4. 4106132 A Battery and Wire Assembly
5. 4106077 F Plate
6. 4106087 P Capacitor
7. 4106085 P Transformer
8. 4106316 P Fuse 0.5 Amp
9. 4106084 A Printed Circuit Board & Harness Assembly
10. 4106095 A Power Cord Assembly
11. 4106189 P Foam Cushion - inside box 3 x 5 x 1/2
12. 4106086 A Receptacle Assembly 1
13. 4106063 A Receptacle Assembly 2
14. 4106169 A Plug Assembly 3 Pin Power
15. 4106090 P Circuit Breaker 2.0 Amp (2x)
16. 4106092 P Circuit Breaker 1.5 Amp
17. 4106089 P Circuit Breaker 2 Pole 10.0 Amp
18. 4106091 P Circuit Breaker 2 Pole 1.0 Amp
19. 4106088 P Bracket

Power Cord Assembly

4106095 - A

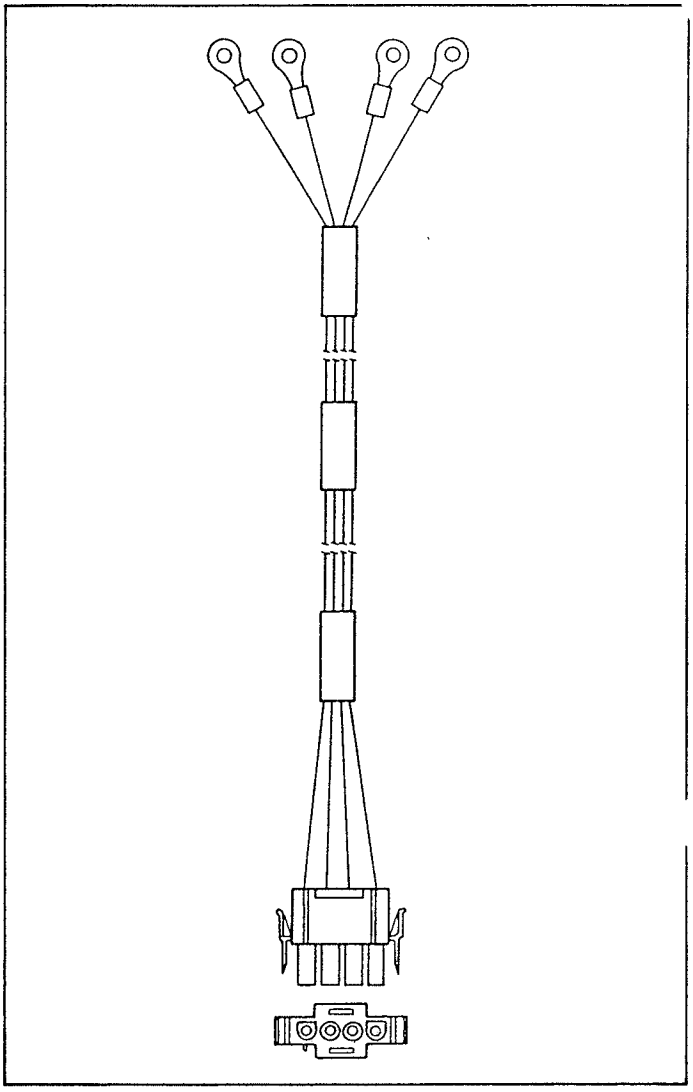


1. 4106560 P Terminal - Flag (2x)
2. 4106144 P Terminal - Ring
3. 4105644 P Strain Relief - 3/8 D
4. 4105103 P Electrical Cord
5. 4104922 P Plug

Wire Harness

Power Supply to Alarm Channel NM2A

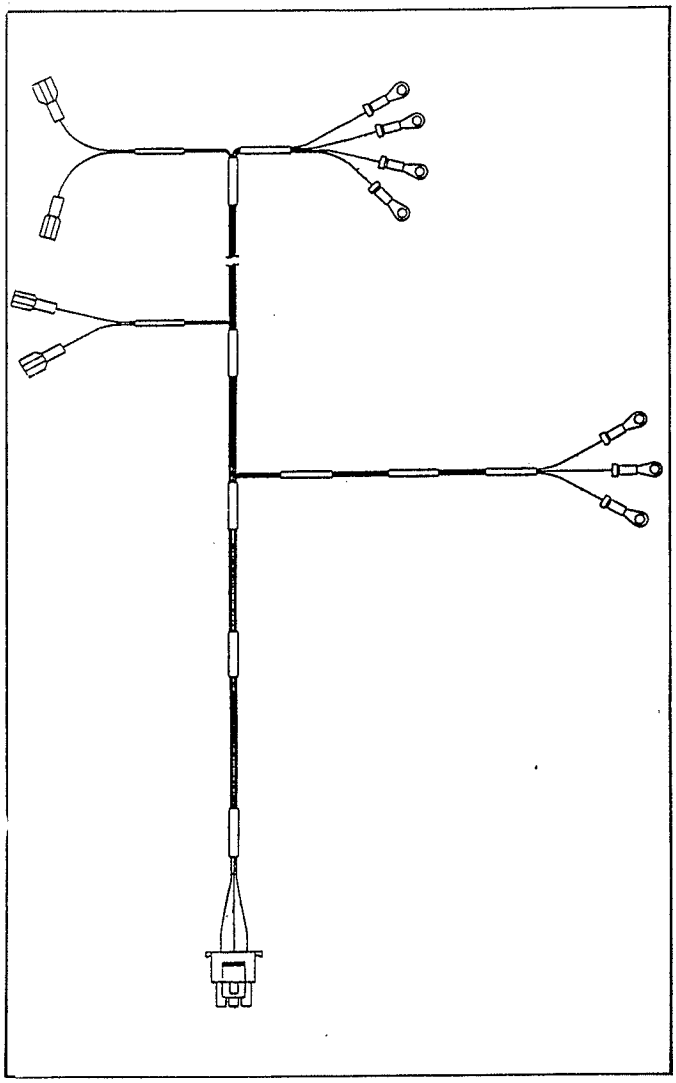
4106264 - A



1. 4106264 A Wire Harness - Power Supply

Wire Harness - Flowmeter Housing NM2A

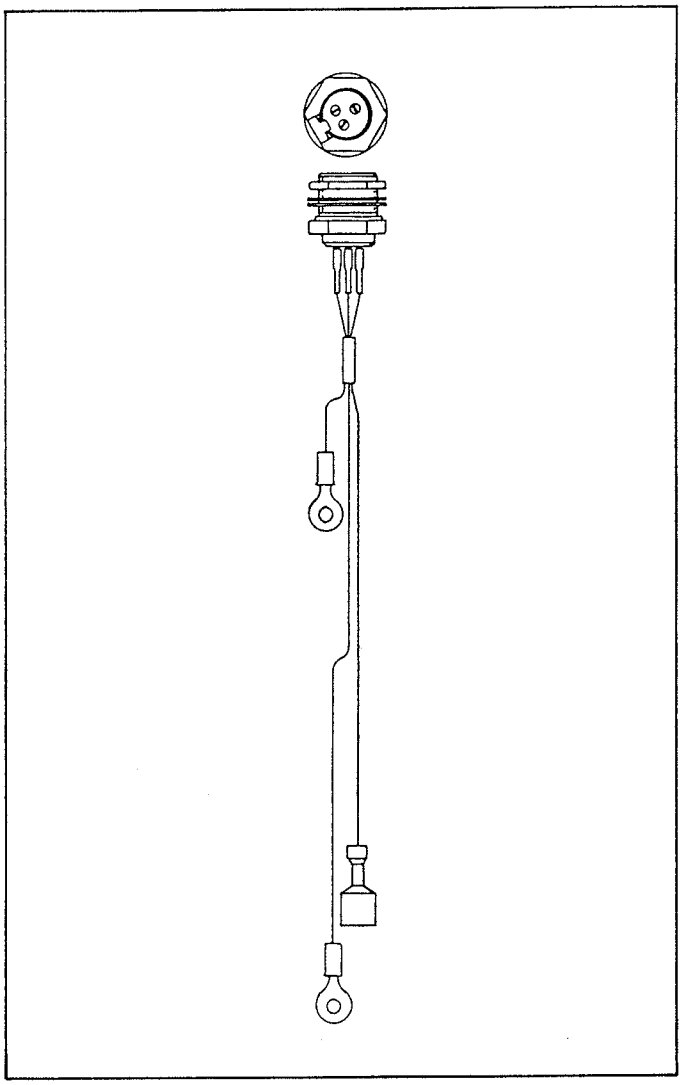
4106246 - A



1. 4106246 A Wire Harness - Flowmeter Housing

Plug Assembly - 3 Pin Power

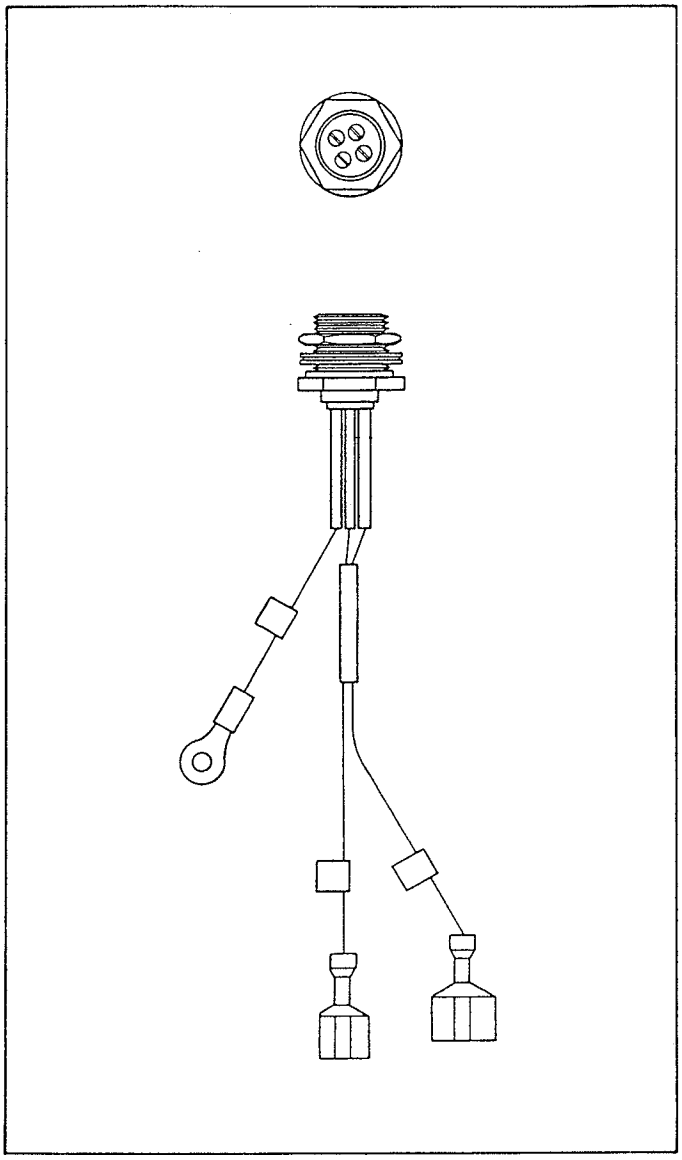
4106169 - A



1. 4106169 A Plug Assembly - 3 Pin Power

Plug Assembly - 4 Pin Power

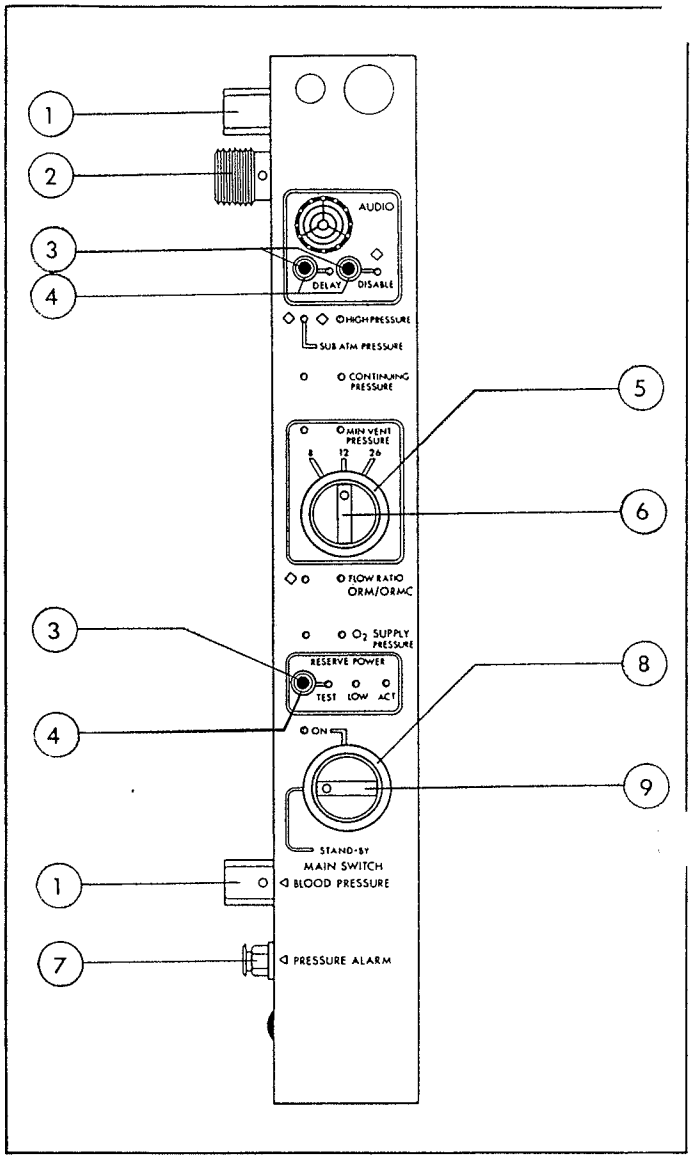
4106265 - A



1. 4106265 A Plug Assembly - 4 Pin Power

Alarm Channel Assembly NM2A (Front View)

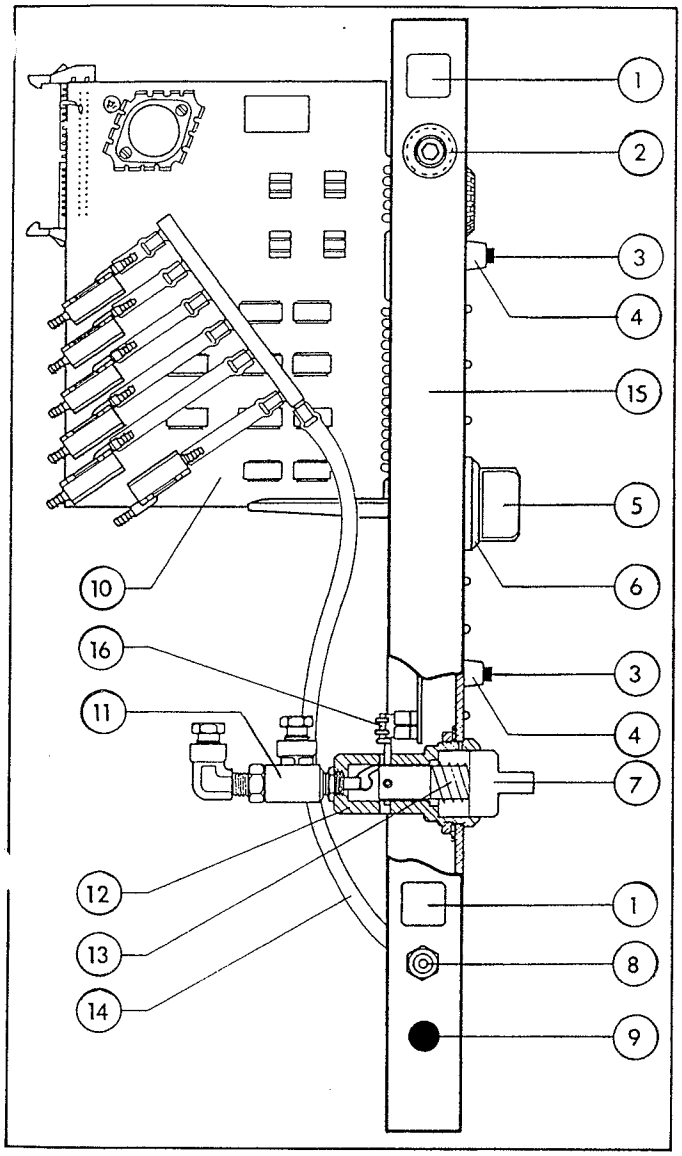
4106053 - A



1. 4103956 F BP Jack (2x)
2. 4102649 M BP Gauge Adapter
3. 4106047 P Push Button (3x)
4. 4106046 P Push Button Housing (3x)
5. 4106049 M Bezel
6. 4103169 F Knob
7. 4103577 F Disconnect Female Adapter
8. 4106045 F Main Switch Housing
9. 4106044 M Main Switch Knob

Alarm Channel Assembly NM2A (Side View)

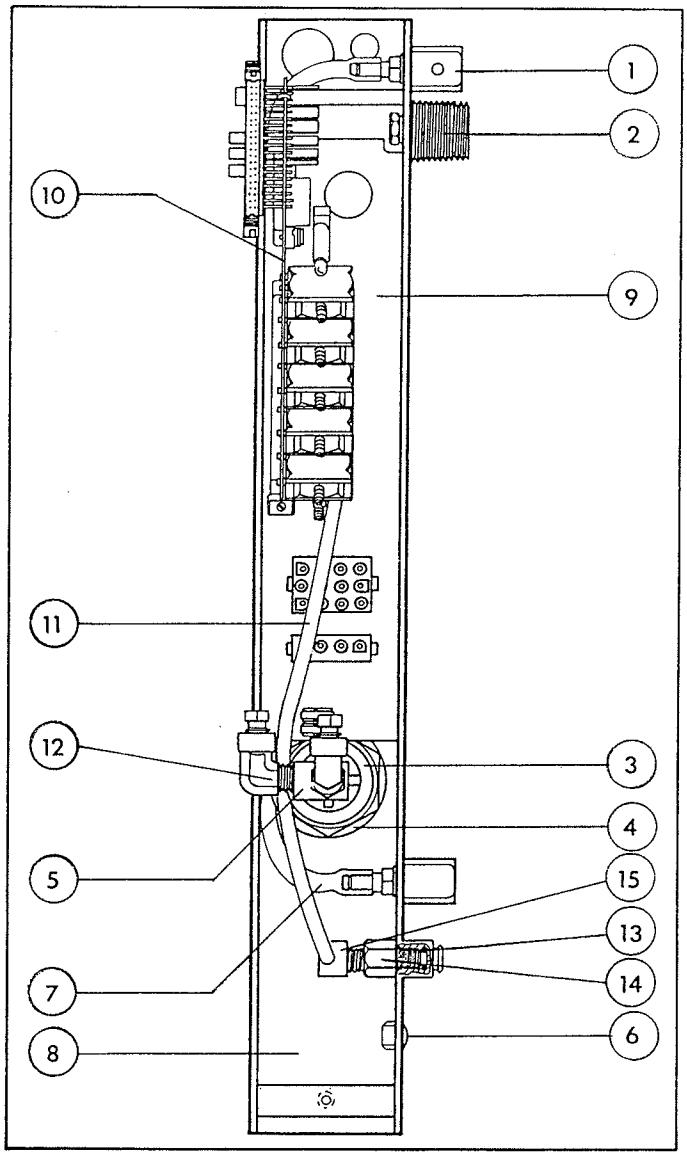
4106053 - A



1. 4103956 F BP Jack (2x)
2. 4102649 M BP Gauge Adapter
3. 4106047 P Push Button (3x)
4. 4106046 P Push Button Housing (3x)
5. 4103169 F Knob
6. 4106049 M Bezel
7. 4106044 M Main Switch Knob
8. 4103577 F Disconnect Female Adapter
9. 4103369 P Plug 7/16 D
10. 4106674 A Printed Circuit Board Assembly
11. 4103588 P Valve - Clippard
12. 4106045 F Main Switch Housing
13. 4104355 P Spring
14. 8808007 P Tubing - flex 1/4 OD 12 inch (clear)
15. 4106036 S Alarm Channel

Alarm Channel Assembly NM2A (Rear View)

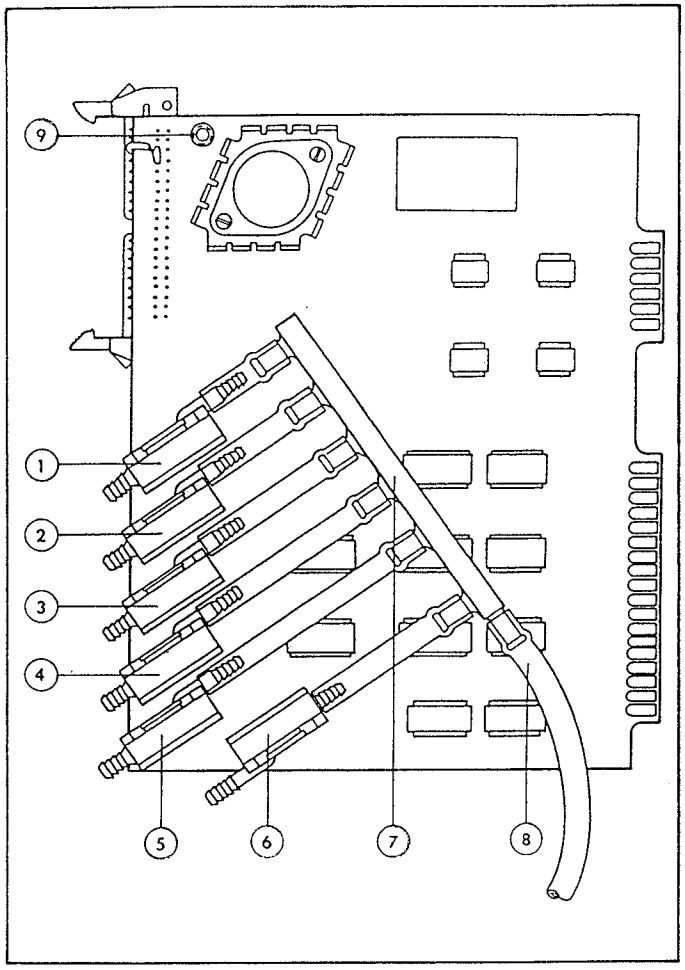
4106053 - A



1. 4103956 F BP Jack (2x)
2. 4102649 M BP Gauge Adapter
3. 4104351 M Nut
4. 7767003 P Washer - Lock internal 1-3/8
5. 4103588 P Valve - Clippard
6. 4103369 P Plug 7/16 D
7. 8808007 P Tubing - flex 1/4 OD 15 3/4 inch (clear)
8. 4106036 S Alarm Channel
9. 4106051 P Printed Circuit Board Assembly
10. 4106674 A Printed Circuit Board Assembly
11. 8808007 P Tubing - flex 1/4 OD 12 inch (clear)
12. 4102720 P Elbow - Male 1/4 D to 1/8 NPT
13. 4101872 P O-Ring 010 - Neoprene
14. 4103655 M Disconnect
15. 4106715 P Elbow - 1/4 D to 1/8 NPT

Printed Circuit Board Assembly NM2A

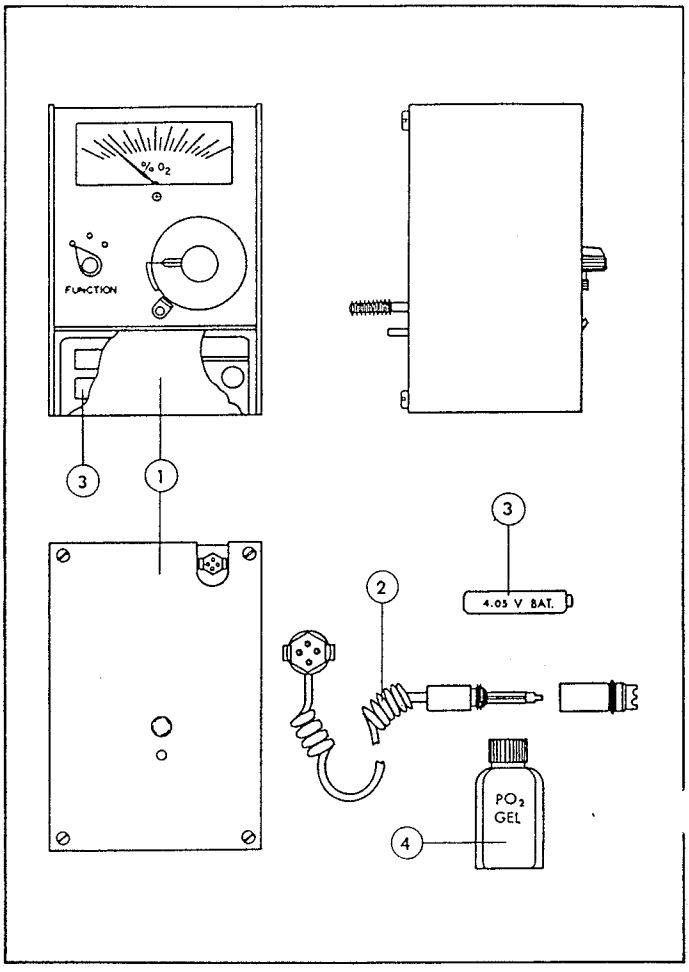
4106674 - A



1.	4104874 P	MPL Pressure Switch - 65cm H_2O NO
2.	4105124 P	MPL Pressure Switch - 26cm H_2O NO
3.	4104873 P	MPL Pressure Switch - 17cm H_2O NO
4.	4105125 P	MPL Pressure Switch - 12cm H_2O NO
5.	4105126 P	MPL Pressure Switch - 8cm H_2O NO
6.	4104871 P	MPL Pressure Switch - 10cm H_2O NO
7.	4106042 P	Manifold Assembly
8.	8808007 P	Tubing - flex 1/4 OD (clear)
9.	4106048 M	Spacer

IL O_2 Monitor

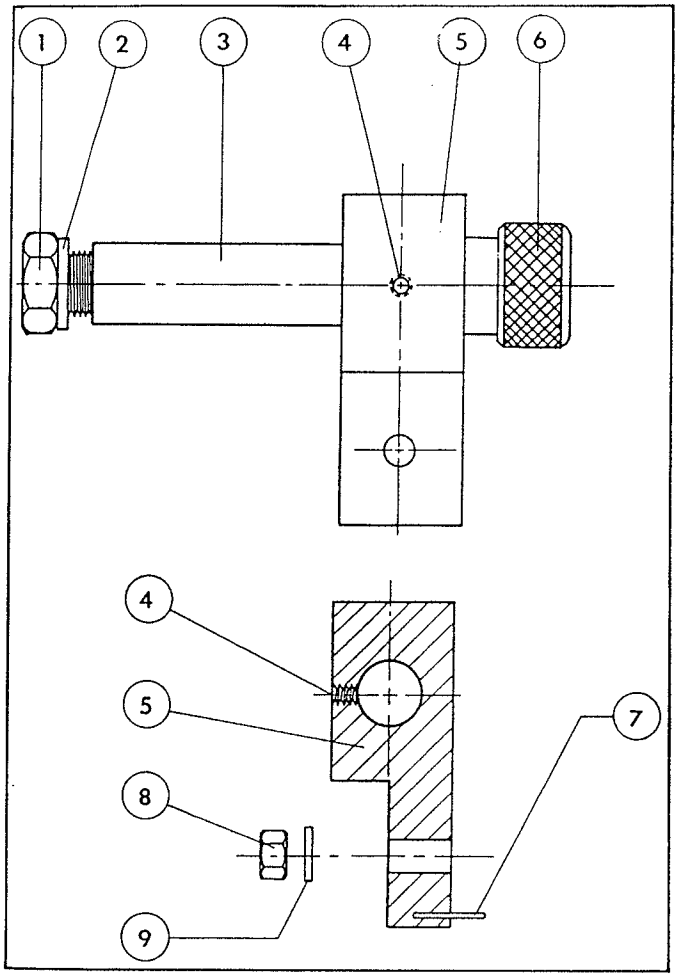
4102229 - A



1.	4102229 P	Monitor - O_2
2.	4103015 P	Sensor - PO_2
3.	4103019 P	4.05 Volt Battery (3x)
4.	4103017 P	Gel - PO_2
		Items Not Shown
5.	4103016 P	Membrane Kit - 3 Caps (1 bottle of gel)
6.	4103018 P	Membrane Caps - 6 Caps

Mount Assembly IL to NM2A

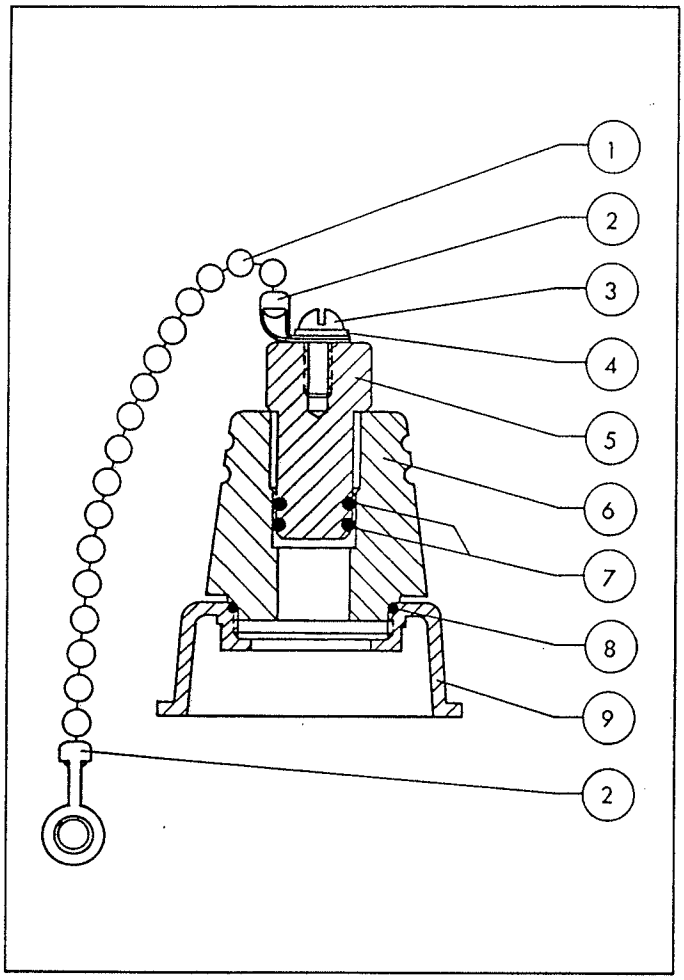
4104339 - A



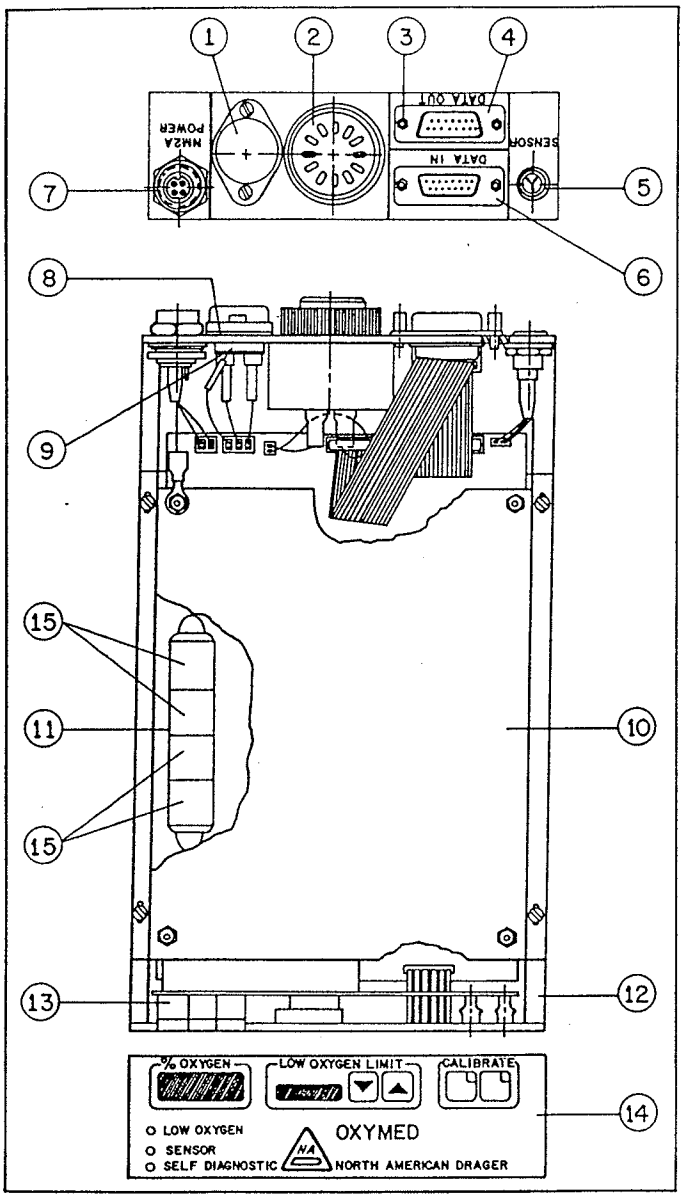
1.	7752001 P	Nut - Hex Jam 1/2-20 ss
2.	7765007 P	Washer - Lock Split 1/2 ss
3.	4104338 F	Rod - Threaded
4.	7707003 P	Screw - Set Cone Pt 6-32x1/4 L ss
5.	4104340 F	Mount
6.	4104337 F	Knob
7.	7775001 P	Pin - Roll 3/32 D x 1/2 L ss
8.	7750006 P	Nut - Hex 1/4-20 ss
9.	7765010 P	Washer - Lock Split 1/4 ss

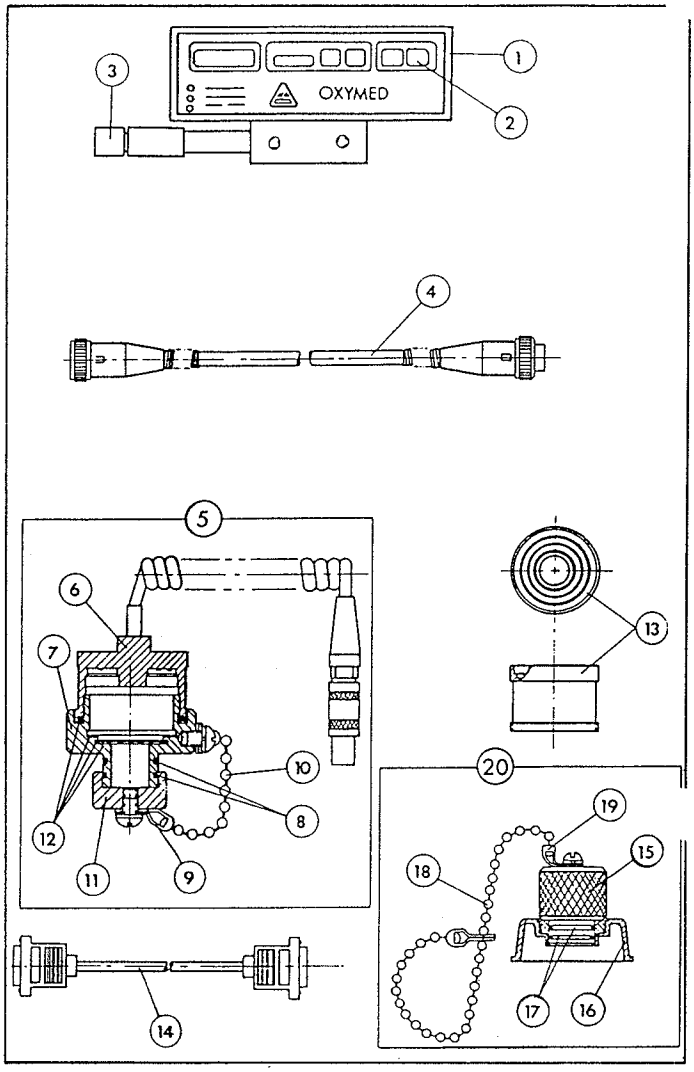
Valve Dome Adapter Assembly IL O_2 Monitor

4102170 - A



1.	4103940 P	Chain 5-3/4 L 10 bead
2.	4101868 P	Chain Coupling - 10 bead (2x)
3.	7706006 P	Screw - Rd Hd Sltd 16-32 x 3/8 L ss
4.	7765003 P	Washer - Lock Split 10 ss
5.	4104835 M	Plug
6.	4102082 M	Adapter - O_2 Sensor
7.	4106070 P	O-Ring 012 - Viton (2x)
8.	4101882 P	O-Ring 022 - Viton
9.	2121482 P	Cap - Plastic



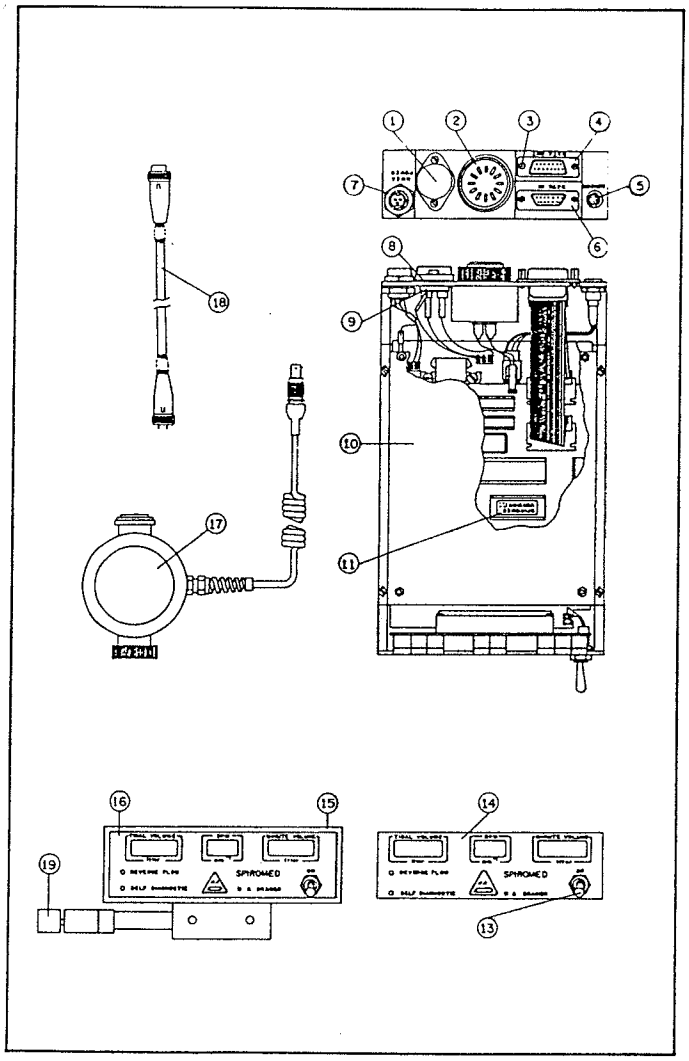


1. 4106365 P Voltage Regulator - 5 VDC
2. 4106349 A Speaker Assembly
3. 4106403 P Spacer (4x)
4. 4106353 A Plug Assembly - Male Jack
5. 4106356 A Plug Assembly - Sensor
6. 4106354 A Plug Assembly - Female Jack
7. 4106352 A Plug Assembly- 4 Pin Power
8. 4106422 P Gasket - Regulator
9. 4106357 A Plug Assembly - Regulator
10. 4106344 A Printed Circuit Board Assembly
11. 8808008 P Sleeve for Batteries
12. 4106308 S Frame Assembly
13. 4106237 P Printed Circuit Board Assembly Display
14. 4106096 P Front Panel
15. 4106423 P Batteries - 1.2 Volt (4x)

1. 4106294 F Housing Assembly
2. 4106200 A Chassis Assembly
3. 4106297 A Mount Assembly
4. 4106410 A Cable Assembly - Power
5. 4106363 A Sensor Assembly
6. 6850250 P Oxygen Sensor Housing
7. 4106385 M Adapter - O_2 Sensor
8. 4106388 P O-Ring 016 - Viton (2x)
9. 4101868 P Chain Coupling - 10 bead
10. 4103940 P Chain 10 bead
11. 4106389 M Plug - O_2 Sensor
12. Items supplied with 6
13. 6803290 P Capsule - O_2 Sensor
14. 4106409 P Data Network Cable - short
15. 4106387 A Plug Assembly with Chain & O-Rings
16. 4106386 A Valve Dome Adapter Sub-Assembly
17. 4106388 P O-Ring 016 - Viton (2x)
18. 4103940 P Chain 10 bead
19. 4101868 P Chain Coupling - 10 bead (2x)
20. 4106336 A Valve Dome Adapter

Spiromed with Pole Mount

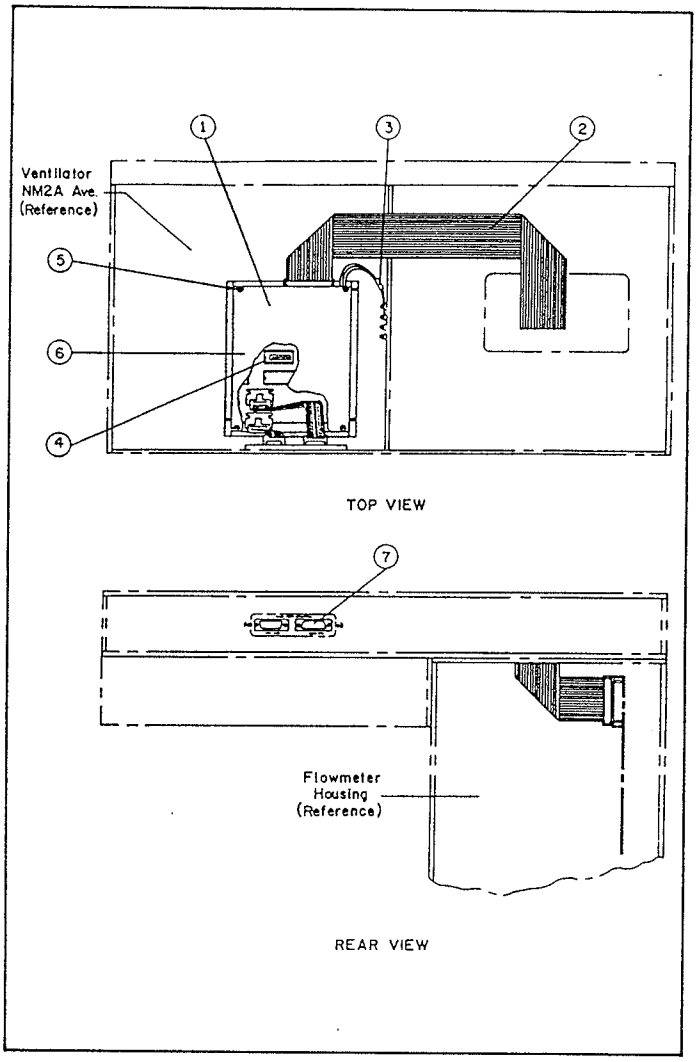
4106301 - A



1.	4106365 P	Voltage Regulator - 5 VDC
2.	4106349 A	Speaker Assembly
3.	4106403 P	Spacer (4x)
4.	4106353 A	Plug Assembly - Male Jack
5.	4106356 A	Plug Assembly - Sensor
6.	4106354 A	Plug Assembly - Female Jack
7.	4106351 A	Plug Assembly- 3 Pin Power
8.	4106422 P	Gasket - Regulator
9.	4106357 A	Plug Assembly - Regulator
10.	4106345 P	Shield - upper
11.	4106428 M	Program Memory
12.	4106343 A	Printed Circuit Board Assembly
13.	4106329 A	Switch Assembly - on/off
14.	4105923 P	Monitor Panel
15.	4106294 F	Housing Assembly
16.	4106300 A	Chassis Assembly
17.	4106362 A	Sensor Assembly
18.	4106411 A	Power Cable - long
19.	4106297 A	Mount Assembly

NM2A Data Interface

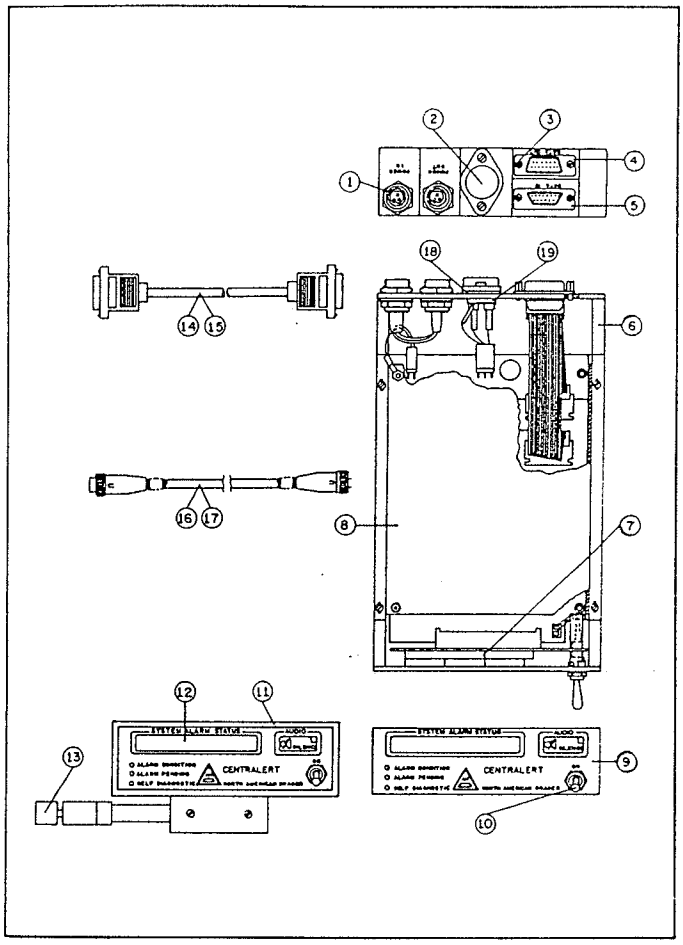
4106900 - A



1.	4106901 A	Printed Circuit Board & Shield Assembly
2.	4106910 P	Cable Assembly
3.	4106909 A	Wire Harness
4.	4106908 M	Program Memory
5.	4106905 P	Spacer (4x)
6.	4106345 P	Shield - upper
7.	4106902 A	Connector

Centralert with Pole Mount

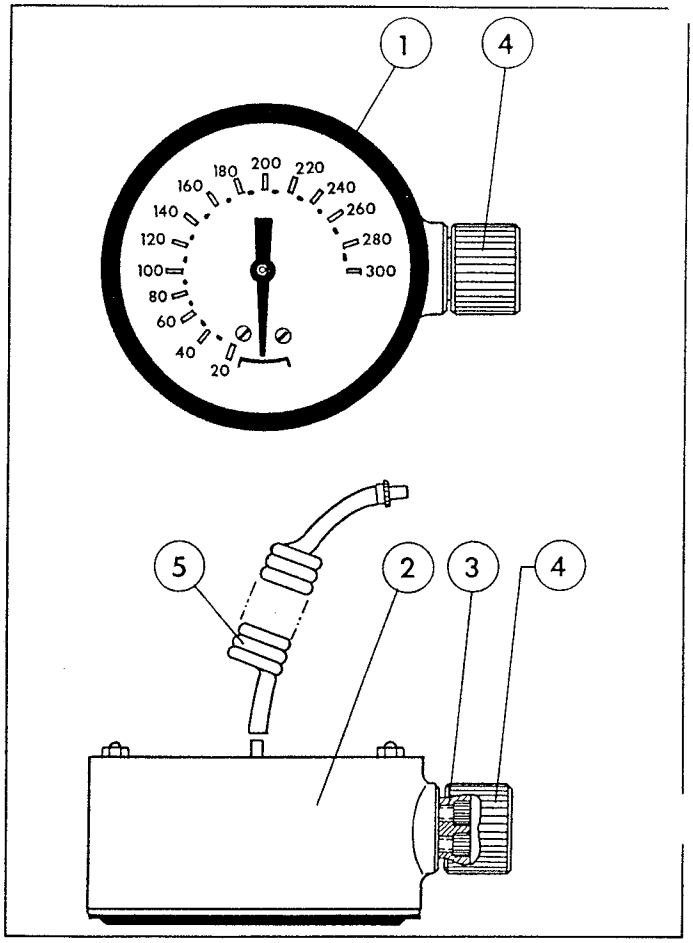
4106701 - A



1.	4106751 A	Plug Assembly - Dual 3 Pin Power
2.	4106365 P	Voltage Regulator - 5 VDC
3.	4106403 P	Spacer (4x)
4.	4106353 A	Plug Assembly - Male Jack
5.	4106354 A	Plug Assembly - Female Jack
6.	4106703 S	Frame Assembly
7.	4106712 P	Printed Circuit Board - Display
8.	4106743 A	Printed Circuit Board & Shield Assembly
9.	4106702 P	Front Panel
10.	4106329 A	Switch Assembly - on/off
11.	4106294 F	Housing - Monitor
12.	4106700 A	Chassis Assembly
13.	4106297 A	Mount Assembly
14.	4106408 P	Cable Data Network - long
15.	4106409 P	Cable Data Network - short
16.	4106411 A	Power Cable - long
17.	4106412 A	Power Cable - short

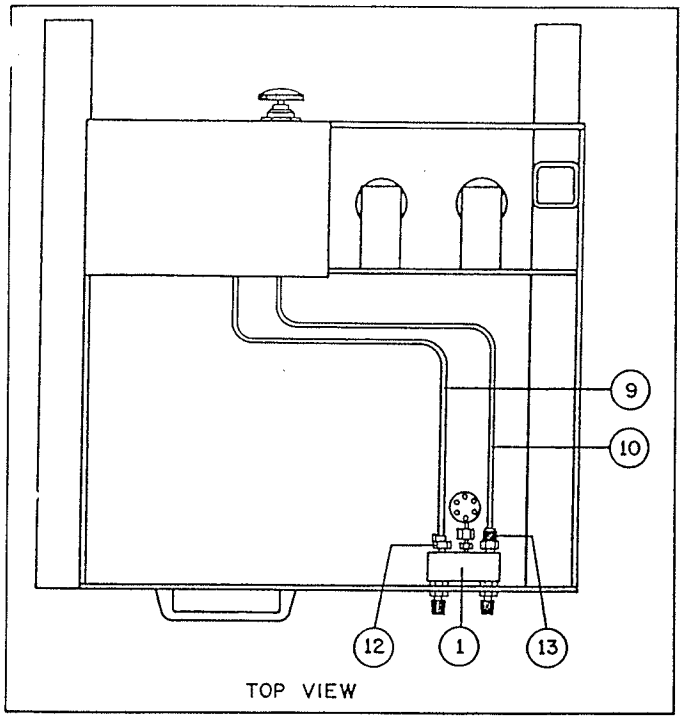
NAD Sphygmomanometer Assembly

4102647 - A

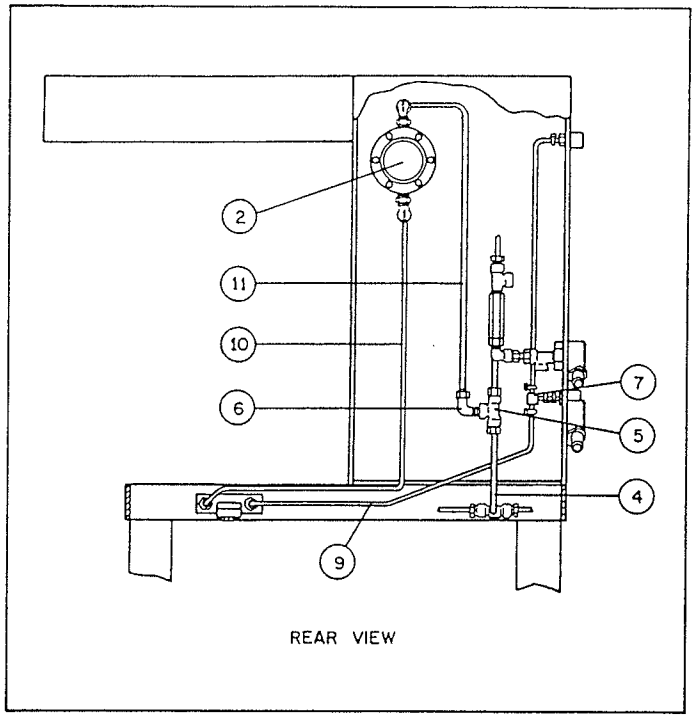


1.	4102716 P	mm Hg Gauge
2.	4105910 F	BP Gauge Housing
3.	4102600 F	Connector
4.	4102601 F	Nut
5.	4103084 P	Tubing - Coil

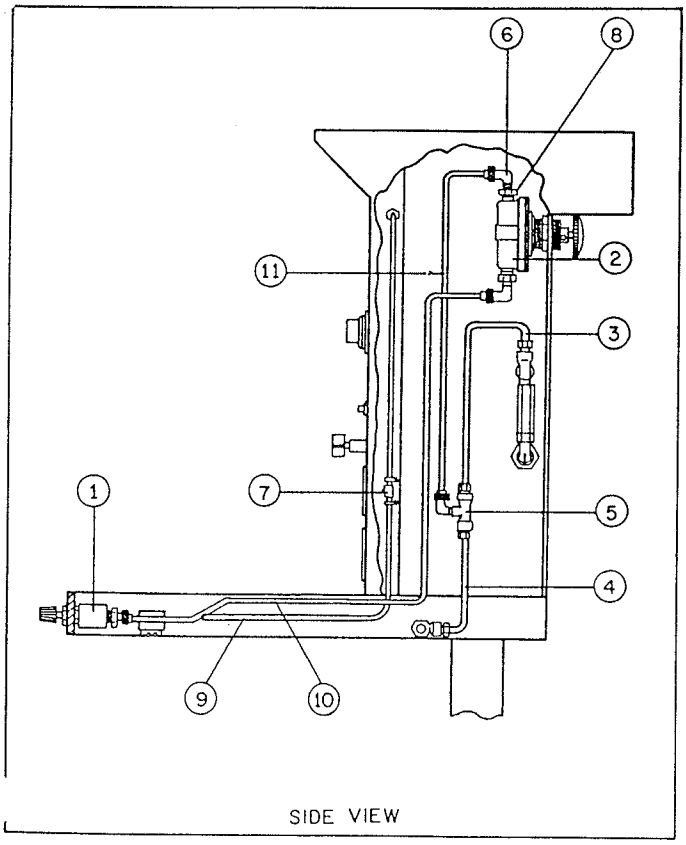
Cuff Inflation System NM2A (1)
4105772 - A



TOP VIEW



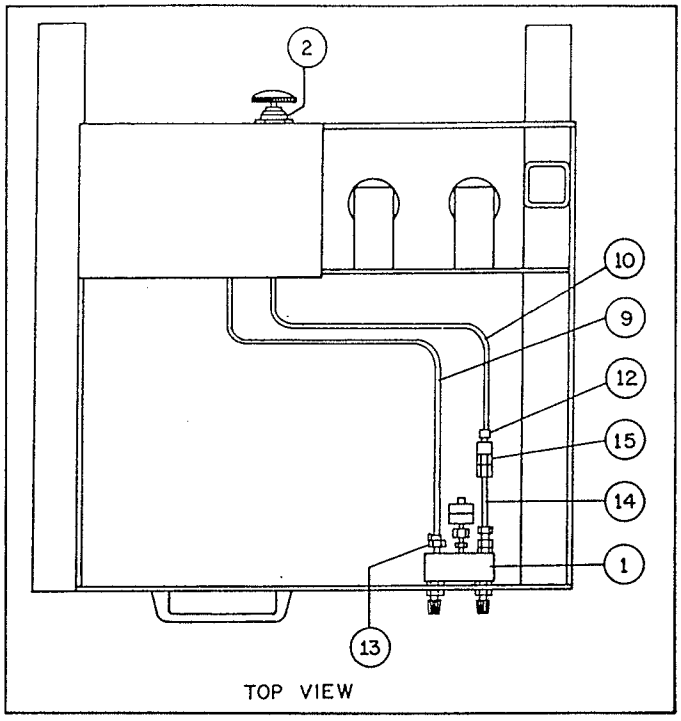
REAR VIEW



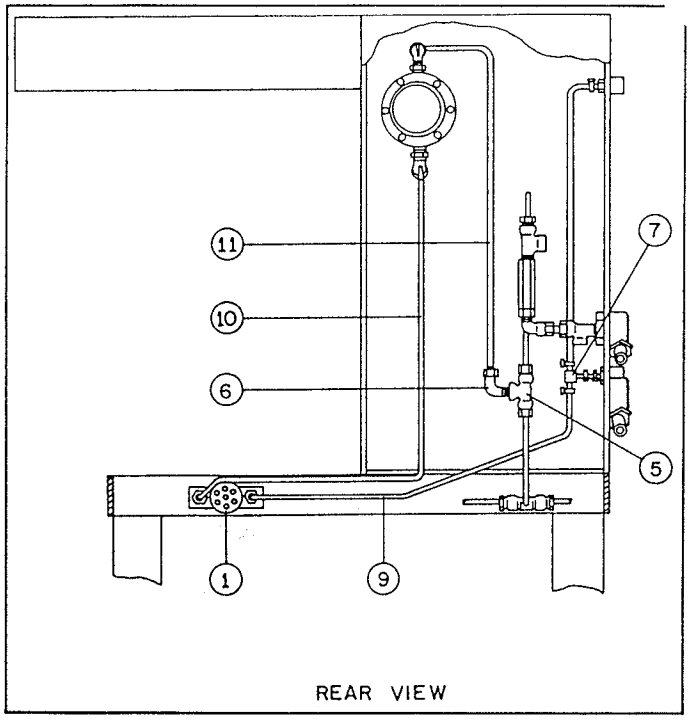
SIDE VIEW

1.	S4106741	P	Valve - Bleed & Inflation Kit
2.	S4106742	P	Regulator - w/ Kit 1
3.	4106837	M	Tubing - Cu
4.	4106838	M	Tubing - Cu
5.	4102770	P	Tee - Female Branch 1/4 D to 1/8 NPT
6.	4102776	P	Elbow - Male 1/8 NPT to 1/4 Hose
7.	4104341	P	Tee - Fitting 3 Way 1/4 D Hose
8.	4102906	P	Bushing - 1/4 NPT to 1/8 NPT
9.	8808002	P	Tubing - flex 1/4 OD 40 inch (clear)
10.	8808006	P	Tubing - flex 1/4 OD 18 inch (White)
11.	8808006	P	Tubing - flex 1/4 OD 34 inch (White)
12.	4102774	P	Connector - Male 1/8 NPT to 1/4 D Hose
13.	4102963	P	Fitting - 1/8 NPT to 1/4 Hose

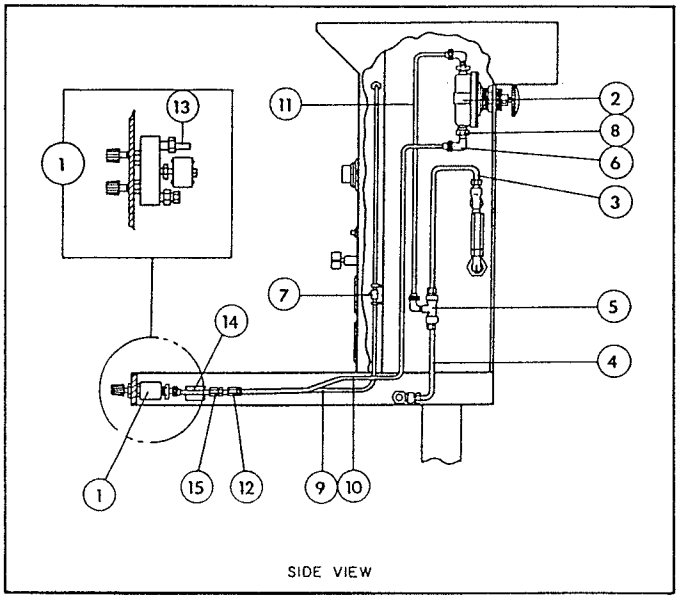
Cuff Inflation System NM2A (2)
4105772 - A



TOP VIEW



REAR VIEW

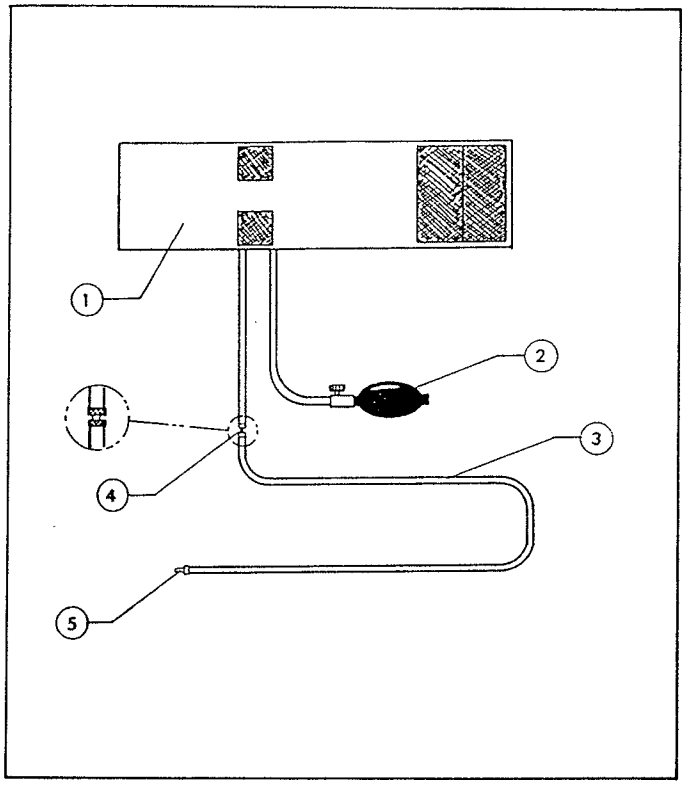


SIDE VIEW

1.	S4106741	P	Valve - Bleed & Inflation Kit
2.	S4106742	P	Regulator - with Kit 1
3.	4106837	M	Tubing - Cu
4.	4106838	M	Tubing - Cu
5.	4102770	P	Tee - Female Branch 1/4 D to 1/8 NPT
6.	4102776	P	Elbow - Male 1/8 NPT to 1/4 Hose
7.	4104341	P	Tee - Fitting 3 Way 1/4 D Hose
8.	4102906	P	Bushing - 1/4 NPT to 1/8 NPT
9.	8808002	P	Tubing - flex 1/4 D 40 inch (clear)
10.	8808006	P	Tubing - flex 1/4 D 18 inch (White)
11.	8808006	P	Tubing - flex 1/4 D 34 inch (White)
12.	4102773	P	Connector - Female 1/8 NPT to 1/4 D
13.	4102963	P	Fitting - 1/8 NPT to 1/4 Hose
14.	8807004	P	Tubing - 1/4 D 6 inch Cu
15.	4102723	P	Connector - Male 1/4 D to 1/8 NPT

Cuff Inflation System

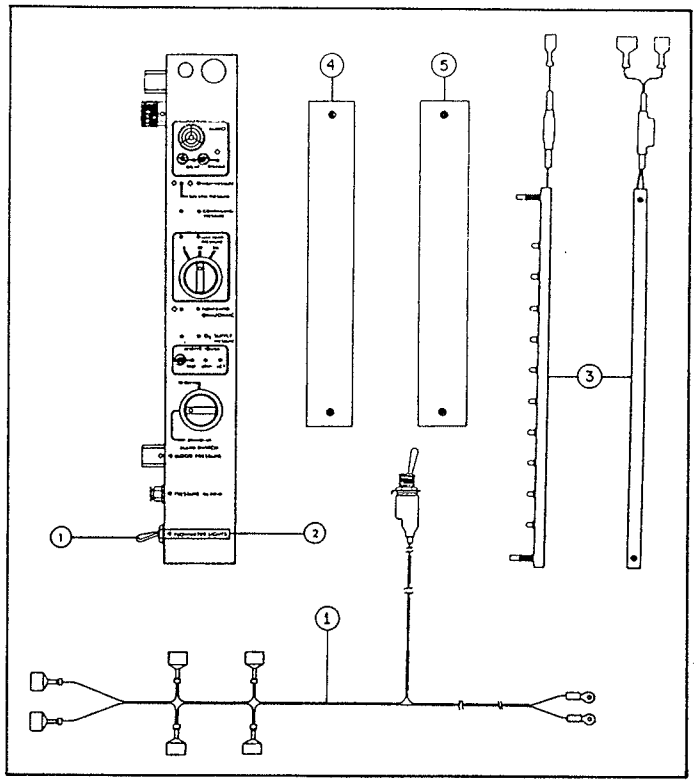
1100606 - A



1.	9988005 A	Cuff & Blatter Assembly
2.	5088010 A	Valve & Bulb
3.	4104244 P	Hose
4.	9997030 A	Luer Connector Set
5.	1101395 F	Luer - Male

Flowmeter Light Assembly 2 Gas

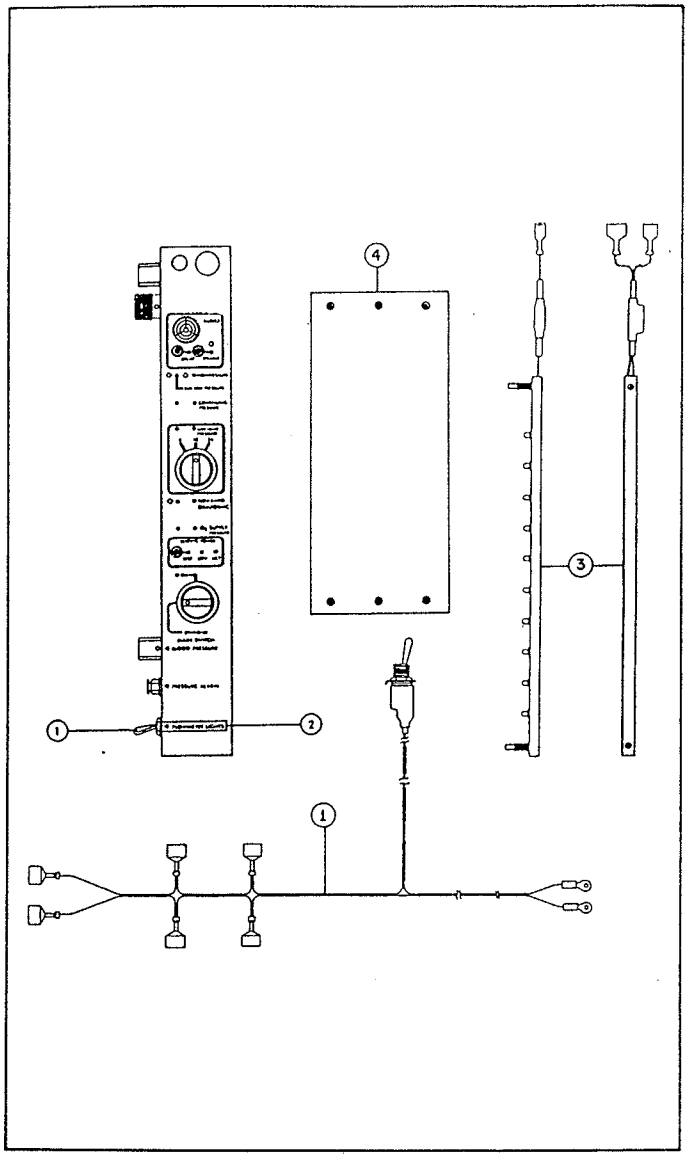
4104740 - A



1.	4106149 A	Toggle Switch Wire Assembly
2.	4105186 P	Flowmeter Lights Label
3.	4106152 A	Channel Light Assembly (2x)
4.	4103346 M	Shield Flowmeter - left
5.	4103347 M	Shield Flowmeter - right

Flowmeter Light Assembly 3 Gas

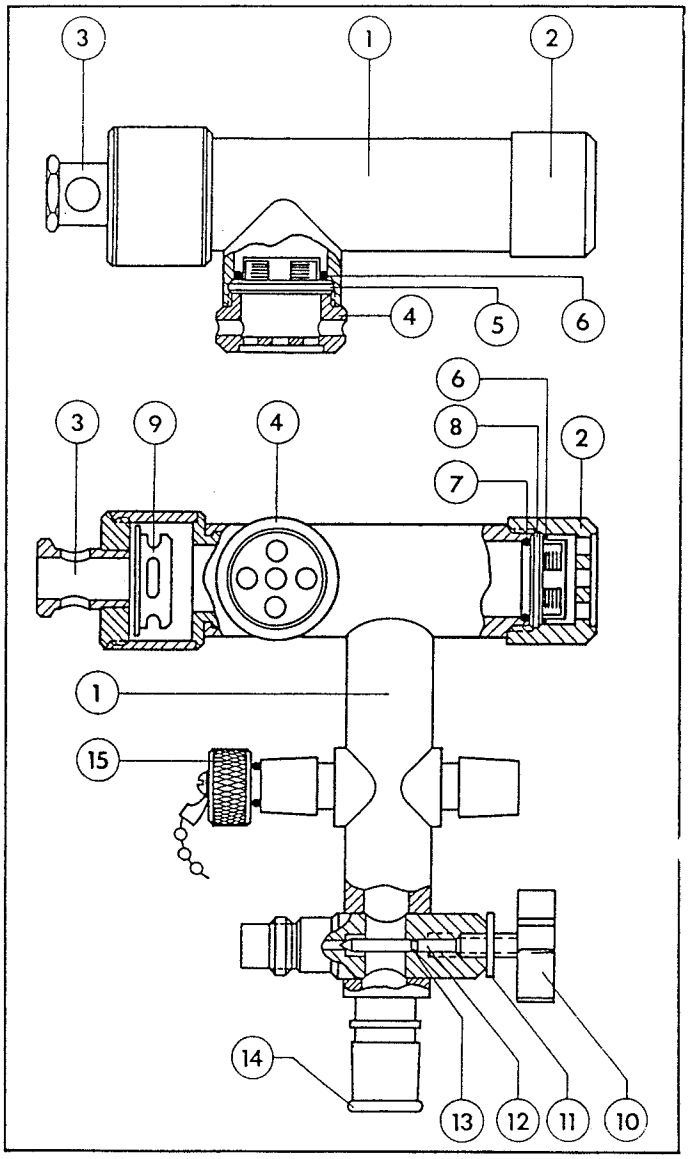
4106150 - A



1. 4106149 A Toggle Switch Wire Assembly
2. 4105186 P Flowmeter Lights Label
3. 4106152 A Channel Light Assembly (3x)
4. 4104735 M Shield Flowmeter - 3 Gas

Scavenger Interface for Hospital Vacuum System

4102088 - A

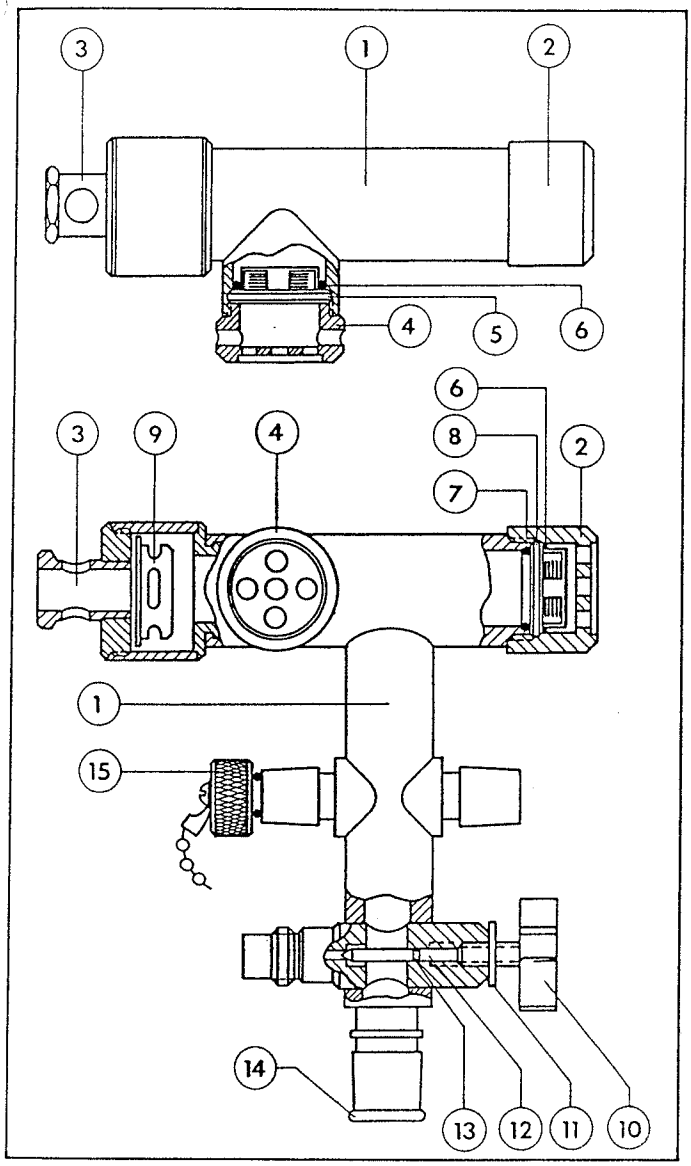


1. 4102030 F Valve Housing
2. 4102035 F Dust Cap
3. 4104659 F Cap Solder Assembly
4. 4102036 M Dust Cap
5. 7264277 P A-Valve Assembly
6. 4102037 M Washer - 1 1/8 ID - Teflon
7. 4102038 P O-Ring 215 - Neoprene
8. 2207032 P A-Valve Assembly
9. 2116219 P A-Valve Assembly
10. 4105699 P Wing Nut - Black Plastic
11. 4105990 F Lock Nut
12. 4102068 M Spindle ss
13. 4102022 P O-Ring 008 - Neoprene
14. 4102894 F Bag Connector - Black Nylon
15. 4102098 A Sealer Plug Assembly

(continued)

Scavenger Interface for Hospital Vacuum System

4102088 - A

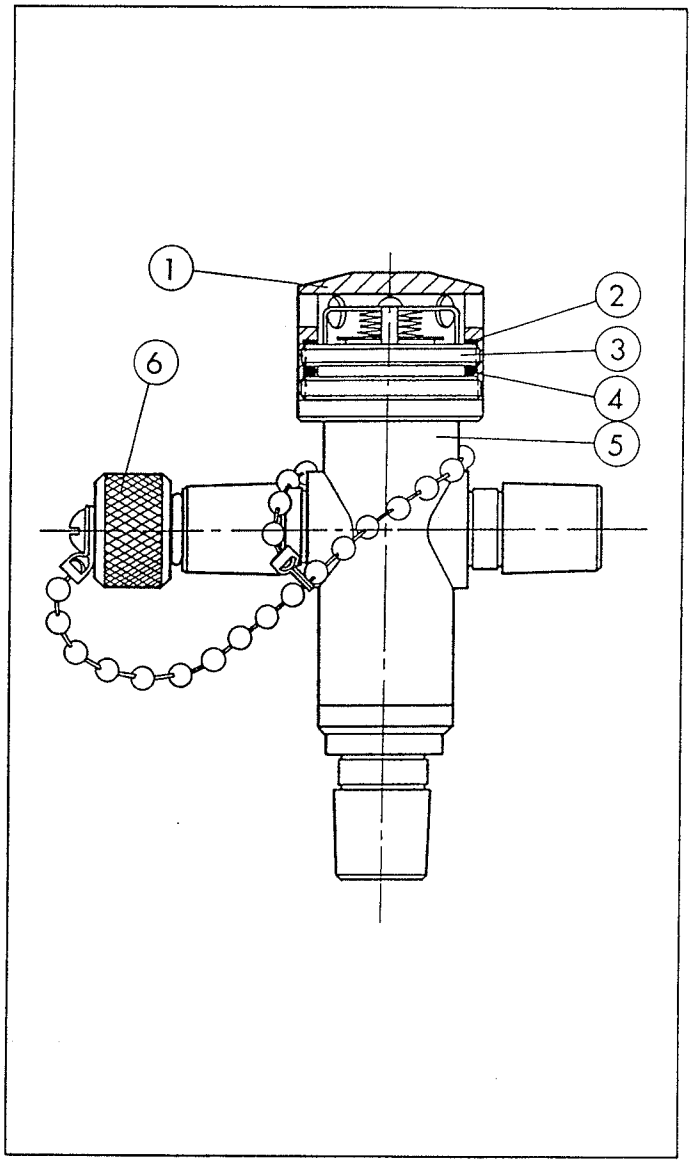


*Items Not Shown

16.	4103122 P	Nut - Hex Vacuum
17.	4103123 P	Barbed Nipple - Vacuum
18.	4104769 A	Tubing - Scavenging 19mm 30 inch
19.	4105368 A	Tubing - Scavenging 19mm 4 foot
20.	9991875 A	Breathing Bag - 5 liter
21.	4106190 A	Mounting Assembly
22.	4102897 A	Elbow Adapter Absorber Pole
23.	S000080 A	Scavenger Valve Stem Assembly

Scavenger Interface for Air Conditioning

4102104 - A



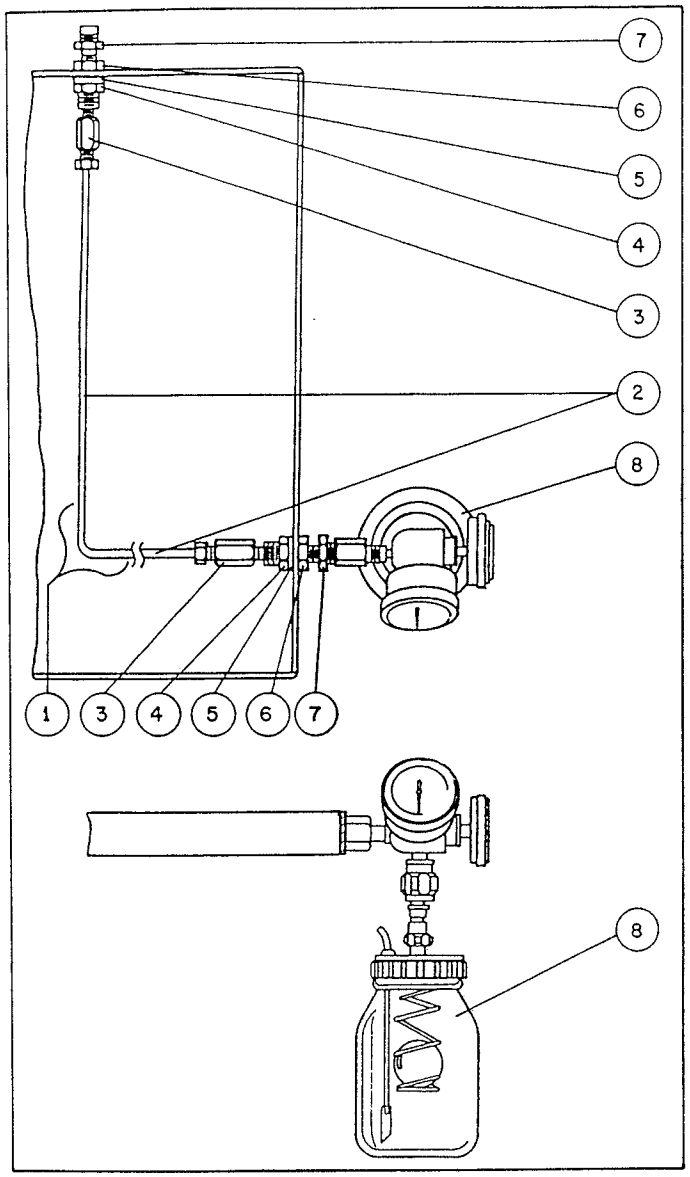
1.	1101527 F	Dust Cover
2.	4102037 M	Washer - 1-1/8 ID - Teflon
3.	2207032 P	A-Valve
4.	4102038 P	O-Ring 215 - Neoprene
5.	4102105 F	Body Assembly
6.	4102098 A	Sealer Plug Assembly

Items Not Shown

7.	4106190 A	Mounting Assembly Scavenger
8.	4104769 A	Tubing - Scavenger 19mm 30 inch
9.	4102897 A	Elbow Adapter Absorber Pole
10.	1101312 A	Ventilator Grill Adapter
11.	4105368 A	Hose - Gas Evacuator 4 foot

Suction System Assembly

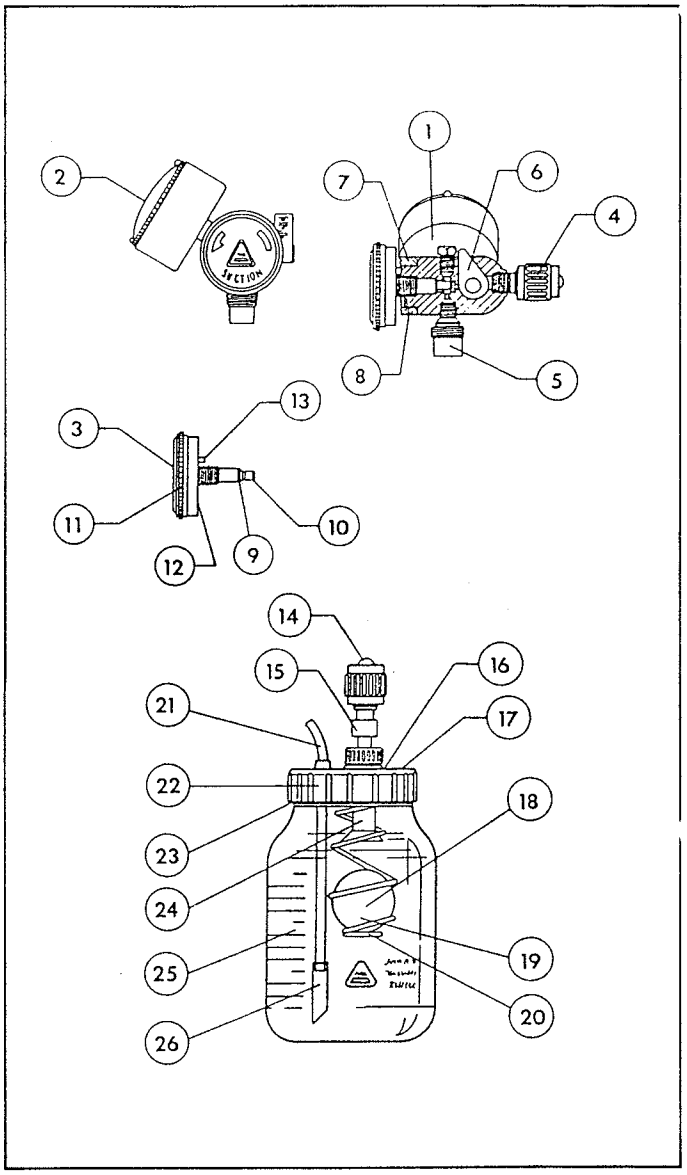
4103350 - A



1. 4105727 A Suction System Piping Assembly
2. 4103919 M Tubing - 1/4 D Cu
3. 4102723 P Connector - Male 1/4 D to 1/8 NPT (2x)
4. 7752002 P Nut - Hex Jam 5/8-18 ss (2x)
5. 7765012 P Washer - Lock Split 5/8 ss (2x)
6. 4103915 F Adapter Suction (2x)
7. 4103669 P Fitting DISS Vacuum
8. 4106328 P Suction Bottle Assembly

Suction Bottle Assembly

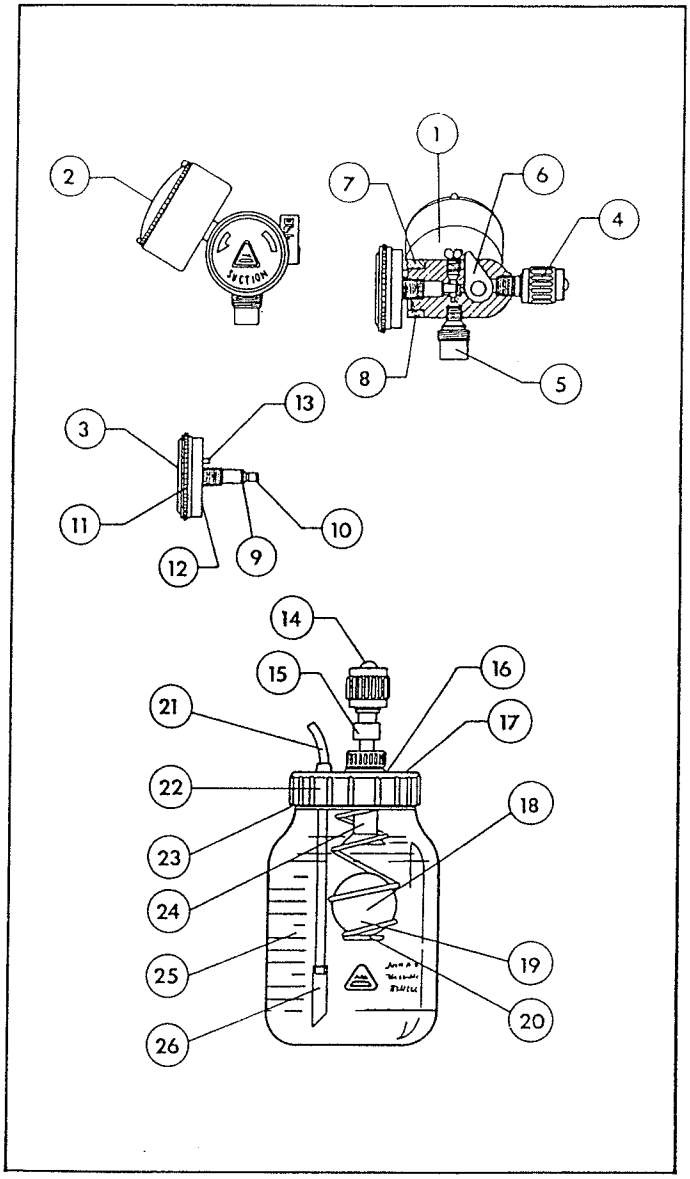
4106328 - P



1. S0447C04 P Suction Gauge Assembly
2. S0443C58 P Plastic Lens
3. S0447C07 P Tracheal Dial
4. S0442C48 P Nut & Stem - DISS 1/4 NPT
5. S0443C01 P Suction - DISS 1/4 NPT Male
6. S0447C11 P Body and Switch Assembly
7. S0442C23 P Locking Collar with Tab Stop
8. S0442C36 P Set Screw for Collar
9. S0443C08 P O-Ring (large) - Diaphragm & Nipple
10. S0443C07 P O-Ring (small) - Diaphragm
11. S0447C06 P Diaphragm Assembly Kit
12. S0447C55 P Screw - Flt Hd 4-48
13. S0442C34 P Stop Screw
14. S0443C08 P O-Ring for Nipple
15. S0443C54 P Fitting - Center Collecting
16. S0443C32 P Washer - Cu

Suction Bottle Assembly

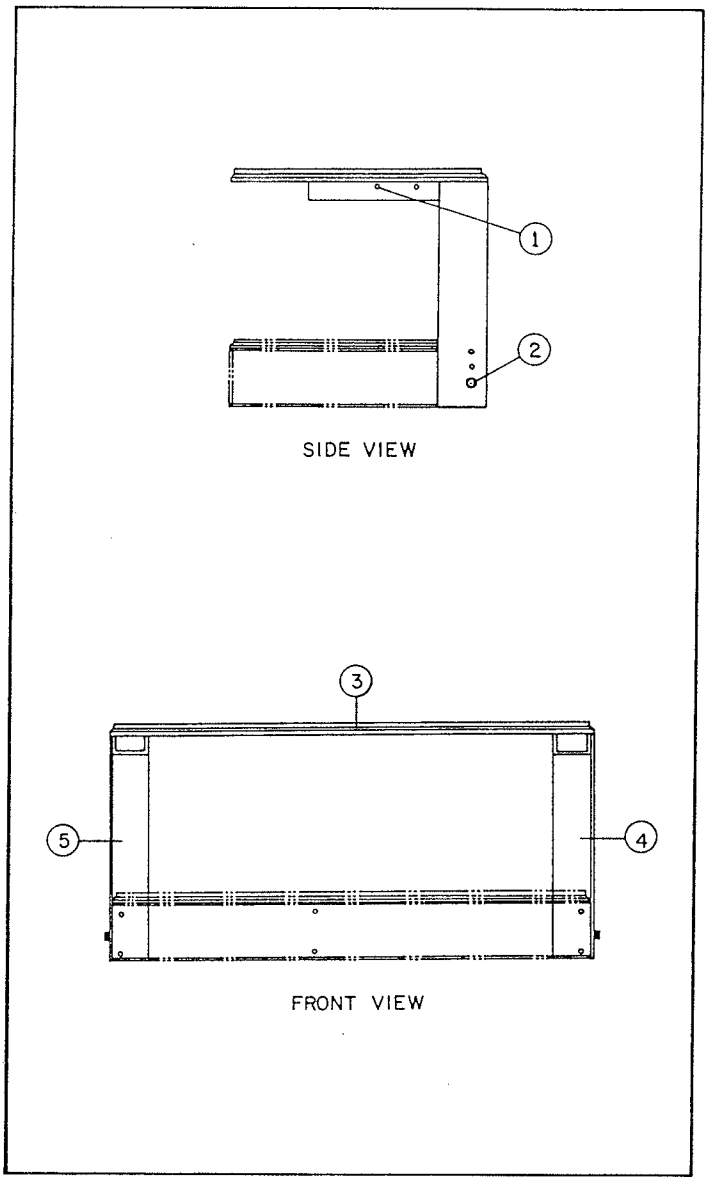
4106328 - P



17. S0443C04 P Center Plate
18. S0443C29 P Float Ball
19. S0443C64 P Cage Assembly
20. S0442C77 P Cage Spring
21. S0443C13 P Inlet Stem - Collecting
22. S0443C11 P Bottle Cap
23. S0443C45 P Gasket for Bottle Cap
24. S0443C28 P Suction Cup
25. S0447C05 P Collecting Bottle
26. S0443C31 P Wash Tub - extension

Shelf Assembly - Low

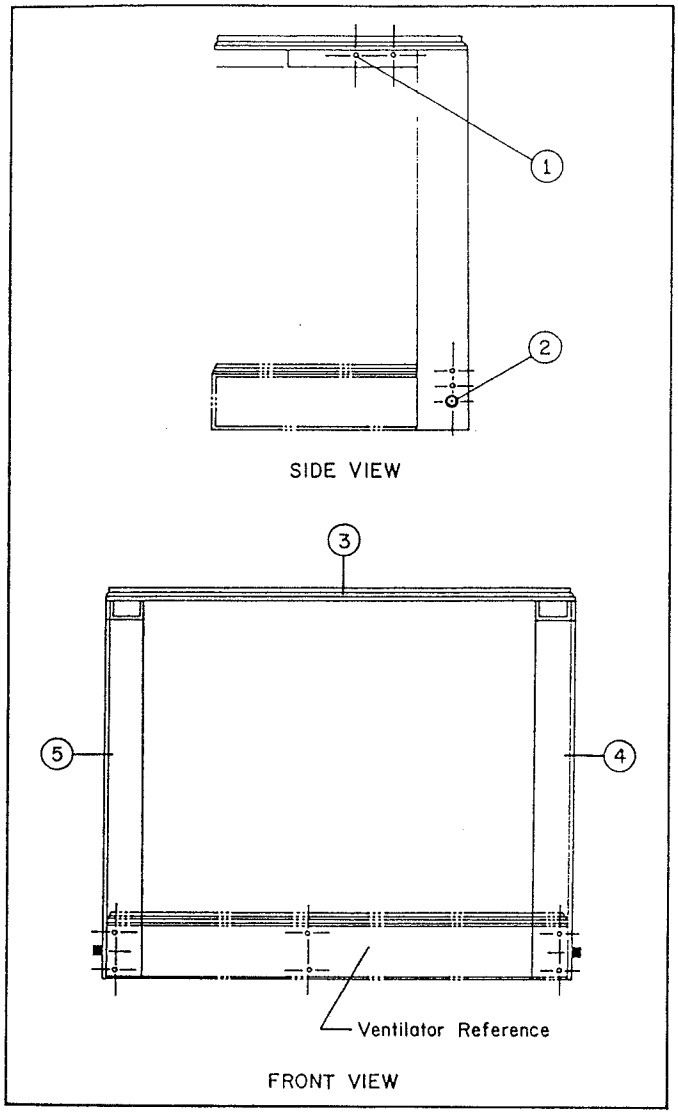
4105106 - A



1. 7701012 P Screw - Cap Skt Hd 8-32 x 3/8 L ss (4x)
2. 7701056 P Screw - Cap Skt Hd 5/16-24 x 3/4 L ss
3. 4105115 A Shelf - extended
4. 4104500 F Right Weld Assembly - low
5. 4104499 F Left Weld Assembly - low

Shelf Assembly - High

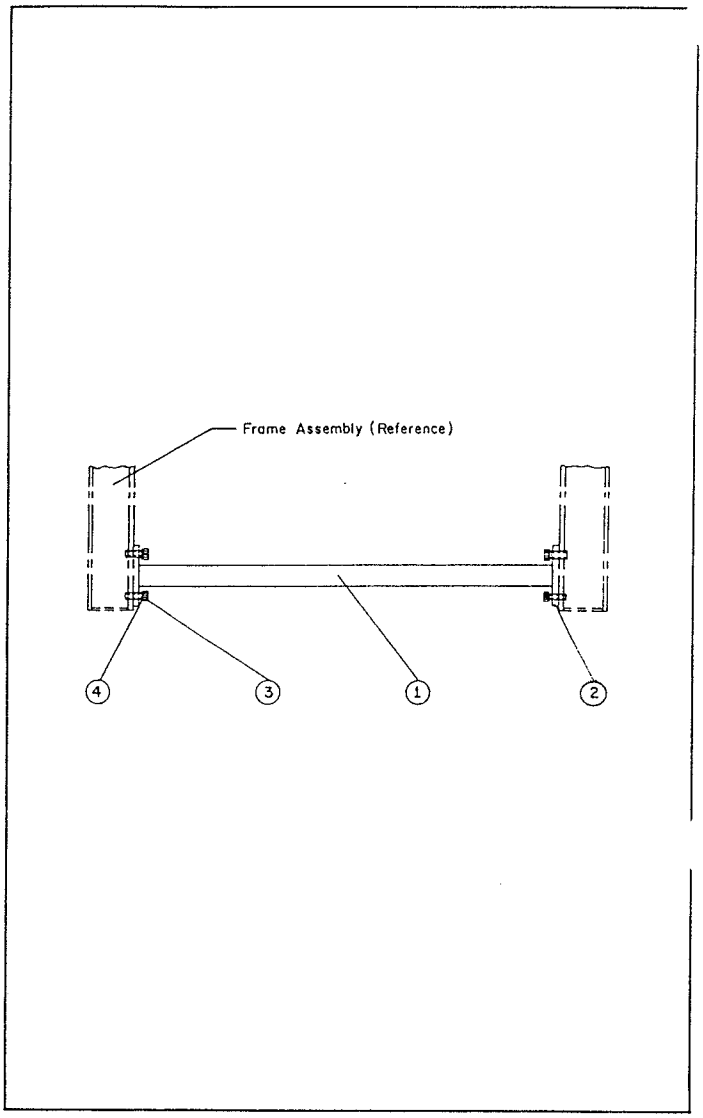
4105120 - A



1.	7701012 P	Screw - Cap Skt Hd 8-32 x 3/8 L ss (4x)
2.	7701056 P	Screw - Cap Skt Hd 5/16-24 x 3/4 L ss
3.	4105115 A	Shelf - extended
4.	4105092 F	Right Weld Assembly - high
5.	4105091 F	Left Weld Assembly - high

Foot Rest - Inside

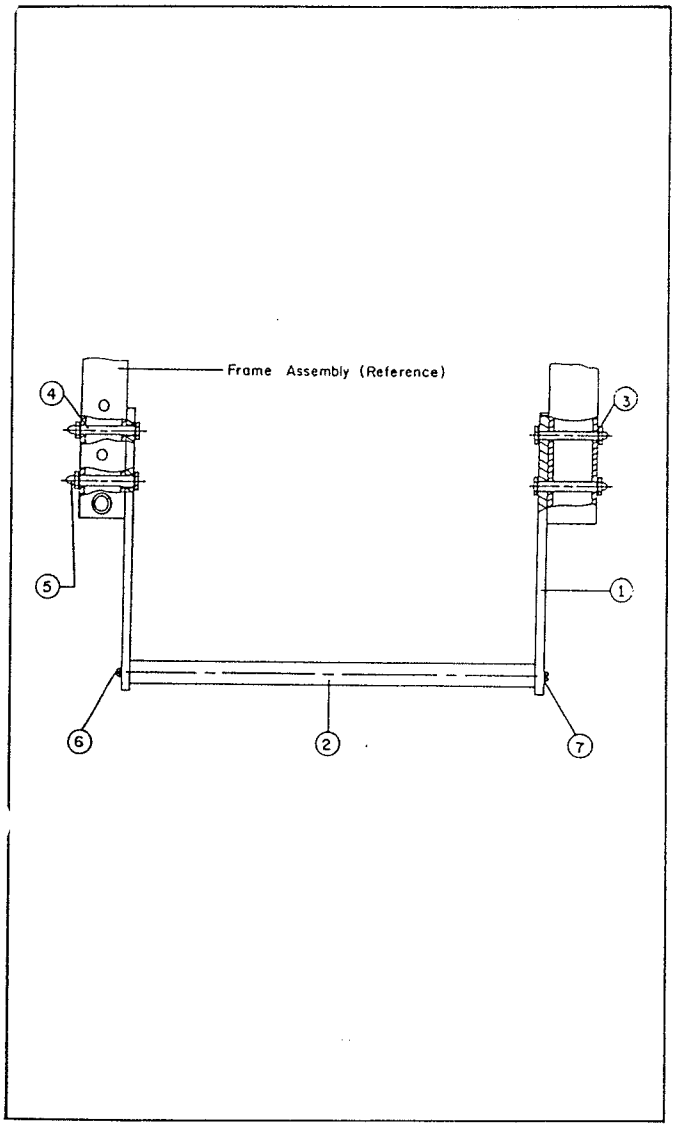
4101921 - A



1.	4105068 F	Foot Solder Assembly
2.	4106753 F	Footrest Plate - Chrome
3.	7701049 P	Screw - Cap Skt Hd 1/4-28 x 5/8 L ss
4.	7765010 P	Washer - Lock Split 1/4 D ss (4x)

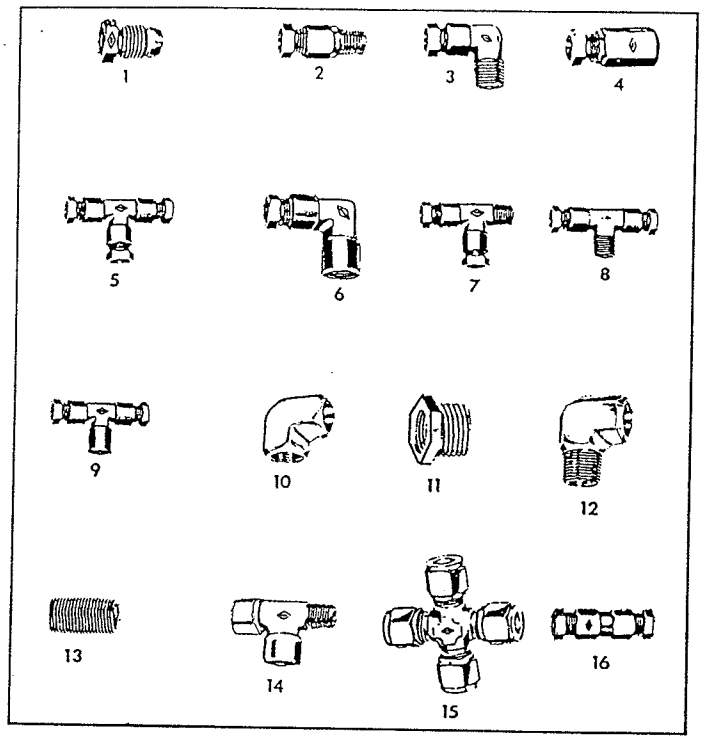
Foot Rest - Outside

4104436 - A



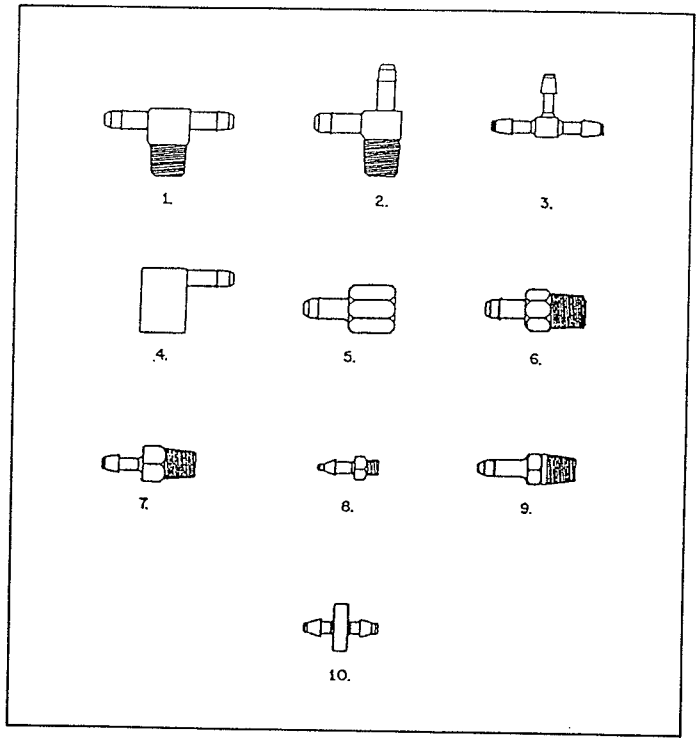
1.	4104433 F	Plate (2x)
2.	4105069 F	Tube Assembly
3.	7766005 P	Washer - Flat 3/8 ss (4x)
4.	7708003 P	Screw - Cap Hex Hd 3/8-16 x 2 3/4 L ss
5.	7751002 P	Nut - Acorn 3/8-16 ss (4x)
6.	7702018 P	Screw - Pan Hd Sltd 10-32 x 3/8 L ss
7.	7765003 P	Washer - Lock Split 10 ss (2x)

Copper Tube Fittings



1. S4104715 P Nut - 1/4 D
   4104716 P Nut - 3/16 D
   4105894 P Plug 1/4 D
   4106052 P Plug 3/16 D
2. 4102723 P Connector - Male 1/4 D to 1/8 NPT
   4102769 P Connector - Male 3/16 D to 1/8 NPT
   4102733 P Connector - Male 1/4 D to 1/4 NPT
3. 4102720 P Elbow - Male 1/4 D to 1/8 NPT
   4102722 P Elbow - Male 3/16 D to 1/8 NPT
   4102707 P Elbow - Male 1/4 D to 1/4 NPT
4. 4102880 P Connector - Female 1/4 D to 1/8 NPT
   4103434 P Connector - Female 3/16 D to 1/8 NPT
5. 4102764 P Union Tee - 3 Way 1/4 D
6. 4102721 P Elbow - Female 1/4 D to 1/8 NPT
7. 4102726 P Tee - Male Run 1/4 D to 1/8 NPT
   4102762 P Tee - Male Run 3/16 D to 1/8 NPT
8. 4102763 P Tee - Male Branch 1/4 D to 1/8 NPT
   4102766 P Tee - Male Branch 3/16 D to 1/8 NPT
9. 4102770 P Tee - Female Branch 1/4 D to 1/8 NPT
10. 4104774 P Elbow - 1/8 NPT to 1/8 NPT
11. 4102906 P Bushing - 1/4 D to 1/8 NPT Reducer
12. 4103513 P Elbow - Street 1/8 NPT to 1/8 NPT
13. 4102784 P Closed Nipple - 1/8 NPT to 1/8 NPT
14. 4102760 P Tee - 3 Way 1/8 NPT to 1/8 NPT
15. 4102772 P Cross - 4 Way 1/4 D to 1/4 D
16. S4102765 P Union -1/4 D to 1/4 D

Vinyl Tube Fittings



1. 4102881 P Tee - 1/8 NPT to Male 1/4 D Tubing
2. 4102878 P Tee - 1/8 NPT to Male 1/4 D Tubing
3. 4102337 P Tee - 3 Way to 1/8 D Tubing
4. 4103443 P Elbow - 1/8 NPT to Female 1/4 D Tubing
5. S4102867 P Fitting - 1/8 NPT to Female 1/4 D Tubing
6. 4102963 P Fitting - 1/8 NPT to Male 1/4 D Tubing
7. 4106366 P Fitting - 1/8 NPT to Male 1/8 D Tubing
8. 4103445 P Fitting - 10-32 to Male 1/8 D Tubing
9. 4102879 P Fitting - 1/16 NPT to Male 1/4 D Tubing
10. 4102164 P Reducer - 1/4 D Tubing to 1/8 D Tubing

O-RINGS

1.	S4104577	P	003 - Neoprene
2.	1101615	P	006 - Teflon
3.	S4102484	P	006 - Neoprene
4.	S2123178	P	007 - Viton
5.	4102576	P	007 - Neoprene
6.	4102022	P	008 - Neoprene
7.	4105960	P	008 - Ethylene Propylene
8.	4105962	P	009 - Viton
9.	4101872	P	010 - Neoprene
10.	1101780	P	011 - Neoprene
11.	4105961	P	011 - Viton
12.	1101523	P	012 - Neoprene
13.	4106070	P	012 - Viton
14.	4102234	P	013 - Neoprene
15.	4104602	P	015 - Neoprene
16.	4106388	P	016 - Viton
17.	4102336	P	018 - Neoprene
18.	4107096	P	019 - Silicone
19.	4105868	P	020 - Silicone
20.	4102021	P	020 - Neoprene
21.	4104576	P	021 - Neoprene
22.	4104595	P	022 - Neoprene
23.	4101882	P	022 - Viton
24.	4101852	P	024 - Neoprene
25.	4105839	P	027 - Silicone
26.	4101871	P	027 - Neoprene
27.	4103688	P	031 - Neoprene
28.	4101856	P	050 - Neoprene
29.	4103225	P	107 - Neoprene
30.	2121929	P	107 - Viton
31.	4104980	P	108 - Viton
32.	S4102793	P	111 - Neoprene
33.	4102141	P	112 - Neoprene
34.	4102792	P	113 - Neoprene
35.	4101870	P	114 - Neoprene
36.	4105771	P	115 - Silicone
37.	4102193	P	115 - Neoprene
38.	1101769	P	116 - Neoprene
39.	4105766	P	117 - Silicone
40.	4102941	P	117 - Neoprene
41.	4105867	P	118 - Silicone
42.	1101539	P	118 - Neoprene
43.	4105866	P	120 - Silicone
44.	4102023	P	120 - Neoprene
45.	4102479	P	121 - Neoprene
46.	4102944	P	124 - Neoprene
47.	4102478	P	125 - Neoprene
48.	4106290	P	130 - Noeprene
49.	4102616	P	131 - Neoprene
50.	4105615	P	144 - Neoprene
51.	4105833	P	149 - Silicone
52.	4104601	P	201 - Neoprene
53.	4102091	P	212 - Neoprene
54.	4101881	P	214 - Viton
55.	4102038	P	215 - Neoprene
56.	4101912	P	216 - Neoprene
57.	4101817	P	217 - Neoprene
58.	4105767	P	222 - Silicone
59.	4102695	P	222 - Neoprene
60.	4102940	P	237 - Neoprene
61.	4101859	P	238 - Neoprene
62.	4102615	P	264 - Neoprene
63.	4101857	P	365 - Neoprene

TUBING AND HOSES

1.	8807003	P	Tubing - 1/4 D Cu
2.	8807004	P	Tubing - 3/14 D Cu
3.	8808004	P	Tubing - 1/2 D Vinyl (clear)
4.	8808002	P	Tubing - 1/4 D Vinyl (clear)
5.	8808003	P	Tubing - 1/8 D Vinyl (clear)
6.	8808007	P	Tubing - 1/4 D Vinyl (clear)
7.	8808006	P	Tubing - 1/4 D Polyethylene (White)
8.	4103982	P	Hose - Fresh Gas
9.	S4104730	P	Hose - Vapor
10.	4104244	P	Hose - Cuff
11.	4103084	P	Hose - Sphygmomanometer coiled
12.	1100150	P	Hose - O_2
13.	1100151	P	Hose - N_2O
14.	4104414	P	Hose - Air
15.	1100149	P	Hose - Vacuum
16.	9999460	A	Hose - 22mm corr 36 inch
17.	9999461	A	Hose - 22mm corr 23 inch
18.	4105368	P	Hose - 19mm corr 48 inch
19.	4104769	A	Hose - 19mm corr 30 inch
20.	9999464	A	Hose - 6mm corr 9 inch
21.	4104777	P	Hose - 19mm corr 10 inch

LABELS

1.	4103175	P	O_2 Flush
2.	4103178	P	O_2 - large (Green)
3.	4103904	P	N_2O - large (Blue)
4.	4103905	P	Air - large (Yellow)
5.	1101768	P	O_2 - small (Green)
6.	1101619	P	N_2O - small (Blue)
7.	4102742	P	Air - small (Yellow)
8.	4102699	P	Bag/Auto
9.	1100561	P	Breathing Bag
10.	1100565	P	Expiration
11.	1100559	P	Inspiration
12.	1101098	P	NAD Round
13.	4104768	P	Test Terminal
14.	1100563	P	Ventilator Hose
15.	4101917	P	Warning Bellows
16.	4103749	P	Warning Ventilator & Absorber
17.	4106063	P	0.5 Amp Fuse - slo blo
18.	4106325	P	1900 psi Max Pressure - O_2 Air
19.	4106327	P	745 psi Max Pressure - N_2O
20.	4106675	P	Battery Back-up System
21.	4104818	P	Check List
22.	4106127	P	Circuit Breaker
23.	4104401	P	Cleaning Procedure - scavenger
24.	4103423	P	Dot - small (White)
25.	4103396	P	Dot - large (White)
26.	4106266	P	Oxymed Power
27.	4104400	P	Scavenger Cleaning
28.	4106267	P	Spiromed Power
29.	4106240	P	Power Cord Hospital Grade
30.	4104432	P	Notice Volume Adjustment
31.	4106126	P	Terminal Strip
32.	4104806	P	Scavenger Hose
33.	4103294	P	Cover Flowmeter Back
34.	4106912	P	ORMc Alarm Channel
35.	4103149	P	Serial Number

REPLACEMENT PARTS
Narkomed Line

PRODUCT NUMBER		DESCRIPTION
4103590	P	Regulator O_2
4103591	P	Regulator N_2O
4103585	M	Regulator Mounting Bracket
1101640	A	Yoke Assembly O_2
1101641	A	Yoke Assembly N_2O
1101643	A	Yoke Assembly He
1101644	A	Yoke Assembly CO_2
1101645	A	Yoke Assembly Air
4102241	A	Yoke Assembly N_2
4103076	P	Gauge Pipeline O_2
4103074	P	Gauge Cylinder O_2
4103100	P	Gauge Pipeline N_2
4103075	P	Gauge Cylinder O_2
4103666	P	Gauge Pipeline Air
4102827	P	Gauge Cylinder Air
4102826	P	Gauge Cylinder CO_2
4103624	P	Gauge Cover
1101636	A	Check Valve Cylinder
1101613	P	Yoke Pin - press in
4105929	M	Yoke Pin - screw in
4103340	P	Valve - Clippard O_2 Flush
4105815	P	Check Valve Pipeline
1101359	P	Foot Pad
4102713	P	Failsafe Assembly
4102724	P	Gasket Flowmeter - large
4102725	P	Gasket Flowmeter - small
1101082	P	Flowmeter He
1101081	P	Flowmeter CO_2
1101083	P	Flowmeter N_2
1101084	P	Flowmetr Air - Dual Taper
4102563	P	Connector - DISS O_2 Male
4102575	P	Connector - DISS N_2O Male
2208115	P	Handle
1101768	P	Label - 3/8 DOT O_2 (Green)
1101619	P	Label - 3/8 DOT N_2O (Blue)
4102742	P	Label - 3/8 DOT Air (Yellow)

EXCEPT SUB COMPACT

4103156	A	Flow Knob O_2
4103736	A	Flow knob Assembly
4103904	P	Label - 5/8 DOT N_2O (Blue)
4103905	P	Label - 5/8 DOT Air (Yellow)
4103352	P	Flow Control Valve
4105883	A	Extension Arm Assembly
4101867	M	Constriction - O_2 Flush

SUB-COMPACT

PRODUCT NUMBER		DESCRIPTION
4105608	A	Flush Assembly O_2
1101655	F	Flush Button O_2
1101768	P	Label - 3/8 DOT (Green)
4105895	M	Constriction
4105632	P	Flowmeter N_2O
4105631	P	Flowmeter O_2
S00B7271	P	Flow Control Valve
S14602LX	P	Flowmeter Shield
4105880	F	Flow Knob O_2
4103260	F	Common Outlet Assembly
4105881	F	Flow Knob - N_2O

NARKOMED COMPACT

4102806	A	Flush Assembly O_2
1101665	F	Flush Button
1101768	P	Label - 3/8 DOT O_2 (Green)
4103175	P	Flush Decal
1101427	P	Vapor Washer
1101135	P	Flowmeter O_2 (Fine)
1101136	P	Flowmeter N_2O (Coarse)
1101094	P	Flowmeter N_2O (Dual Taper)
4102508	M	Flowmeter Shield
4103260	F	Common Outlet Assembly
S1100507	A	Vapor Selector Valve Assembly

NARKOMED STANDARD

1100369	A	Flush Assembly O_2
1101665	F	Flush Button
1101768	P	Label - 3/8 DOT O_2 (Green)
4103175	P	Flush Decal
4103260	F	Common Outlet Assembly
S1100525	P	Label - Vapor Selector Valve
1100465	P	Label - BP Gauge
4101910	F	BP Gauge Jack
1101427	P	Vapor Washer
1101135	P	Flowmeter O_2 (Fine)
1101136	P	Flowmeter O_2 (Coarse)
1101137	P	Flowmeter N_2O (Fine)
1101138	P	Flowmeter N_2O (Coarse)
1100353	M	Flowmeter Shield - 1 Gas
1100343	M	Flowmeter Shield - 3 Gas
1100336	P	Name Plate - Flowmeter
S1100507	A	Vapor Selector Valve Assembly

AM III, NARKOMED 2

PRODUCT NUMBER		DESCRIPTION
4103467	A	ORM Sub-Assembly
4103385	A	Flush Assembly O_2
4103248	F	Flush Ring
4103249	F	Flush Button
4103178	P	Label - 5/8 DOT O_2 (Green)
4103413	A	Common Outlet Assembly
4103417	P	Flowmeter O_2 (Fine)
4103418	P	Flowmeter O_2 (Coarse)
4103419	P	Flowmeter N_2O (Fine)
4103420	P	Flowmeter N_2O (Coarse)
4103307	M	Flowmeter Shield - 1 Gas
4103538	A	Flowmeter Shield - 3 Gas
4103588	P	Valve - Clippard Main Switch

ADDITIONAL PARTS AM III

S4103427	P	Vapor Indicator (Green)
S4103426	P	Vapor Indicator (Orange)
S4103435	P	Rotowink O_2 Supply (Green)

ADDITIONAL PARTS NARKOMED 2

S4104277	M	Rod - Battery Box
S4104397	M	Knob - Battery Box
S4103504	P	Battery - 6 Volt
4104000	A	ORMc Sub-Assembly
4106037	P	Pressure Switch - 30 psi

4104883	P	Valve - Solenoid
4103549	P	Valve - 2 Way Poppet
4104882	P	Valve - Plunger
4103444	P	Pressure Switch - 1 psi
4105121	P	Frequency Thumbwheel Control
4105122	P	I:E Ratio Thumbwheel Control
4103341	P	Switch - Electrical
4105035	A	Printed Circuit Board
4103588	P	Valve - Clippard
4103404	P	Flow Gauge
4102045	P	Flow Regulator
S4105893	P	Flow Regulator Rebuild Kit
4102076	A	Valve - Plunger
1101433	A	Plunger Assembly
1101431	M	Connector - Housing
4102055	P	Pilot Actuator
1101429	M	Housing
1101140	A	Venturi Assembly

REPLACEMENT PARTS
Drager Anesthesia Ventilator

DRAGER AV

PRODUCT NUMBER		DESCRIPTION
4103588	P	Valve - Clippard
4102048	P	Frequency Gauge - specify BPMs
4102044	P	Frequency Regulator
4103404	P	Flow Gauge
4102045	P	Flow Regulator
S4105893	P	Flow Regulator Rebuild Kit
4104423	P	Valve - Manifold
4103668	P	Coupling
4102076	A	Plunger Valve Assembly
1101433	A	Plunger Assembly
1101431	M	Connector - Housing
4102055	P	Pilot Actuator
1101429	M	Housing
1101140	A	Venturi Assembly

ADDITIONAL PARTS FOR STANDARD AV

4102047	P	Switch
S4102527	P	Switch - 1/3 Divide
S4102526	P	Rotowink - 1/3 Divide
4106198	A	Filter Assembly Pipeline
1101162	F	Housing Inlet
4102563	P	Connector - O_2 Inlet Male

DRAGER AVE

S4105432	P	Circuit Breaker
4104921	P	Power Supply 5/250
4105957	P	Power Supply 5/1000

PRESSURE SWITCHES

PRODUCT NUMBER		DESCRIPTION
SWITCH - DEHART		
S4103679	P	2 inch 5cm H_2O NO
S4103687	P	2 inch 5cm H_2O NC
S4104324	P	5 inch 12.5cm H_2O NC
S4104325	P	10 inch 25cm H_2O NC
S4104326	P	5 inch 12.5cm H_2O NO
S4104327	P	4 inch 10cm H_2O NO
S4104334	P	25 inch 63.5cm H_2O NO
S4104673	P	10 inch 25cm H_2O NO
S4104674	P	3 inch 7.5cm H_2O NC
S4104865	P	3 inch 7.5cm H_2O NO
SWITCH - MPL		
S4104868	P	3 inch 7.5cm H_2O NC
4104869	P	5 inch 12.5cm H_2O NC
4104870	P	10 inch 25cm H_2O NC
4104871	P	4 inch 10cm H_2O NO
4104872	P	2 inch 5cm H_2O NO
4104873	P	6 inch 15cm H_2O NO
4104874	P	25 inch 63.5cm H_2O NO
4105124	P	10 inch 25cm H_2O NO
4105125	P	5 inch 12.5cm H_2O NO
4105126	P	3 inch 7.5cm H_2O NO

ALARM CHANNELS & PRINTED CIRCUIT BOARDS

S000047	A	Printed Circuit Board for Narkomed 2 - Dehart Switch w/o 30 sec delay

S000048 A	Printed Circuit Board for Narkomed 2 - Dehart Switch w/ 30 sec delay
S000049 A	Printed Circuit Board for Narkomed 2 - MPL Switch w/ 30 sec delay
S000050 A	Printed Cicuit Board for Narkomed 2 - Dehart Switch w/ AVE-MPL Switch 30 sec delay
S000051 A	Alarm Channel w/o 30 sec delay
S000052 A	Alarm Channel w/ 30 sec delay
S000053 A	Alarm Channel w/ 30 sec delay
S000054 A	Alarm Channel w/ 30 sec delay, light switch, and pilot lin
S000055 A	Alarm Channel w/ 30 sec delay, light switch, and pilot line
S000065 A	Alarm Channe NM 2A
4106674 A	Printed Circuiit Board NM 2A
4103410 A	Alarm Channel - AM III
4103376 A	Printed Circuit - AM III
4103411 A	Connecting Panel - AM III
4105035 A	Printed Circuit Board Assembly - AV-E
4105112 A	Plug-in Printed Circuit Board Assembly - DPM-S and AVM
4105650 A	DPM-S for AVM

*NOTE: A credit of 35% of the purchase price will be issued when the malfunctioning Alarm Channel or Circuit Board is returned to North American Drager within 60 days.

CONVERSION KITS

The following Conversion Kits are for Field Installation and will only be sold to NAD Authorized Technical Service Centers

PRODUCT NUMBER	DESCRIPTION
S4105482 A	Ventilator conversion from AV to AV-E Narkomed 2
S4105483 A	Ventilator conversion from AV to AV-E Narkomed Standard

CONVERSION OF VENTILATOR RELIEF VALVE TO BELLOWS DOME REQUIRES:

4104769 A	Scavenger Hose - 2 each
S4103957 M	Hose Adapter
S4105309 A	Relief Valve Conversion Kit

TRIPLE VAPOR EXCLUSION SYSTEMS FOR NARKOMED 2, AM III, AND NARKOMED STANDARD

NARKOMED 2

S4105417 A	Triple Exclusion System for Narkomed 2

AM III

S000087 A	Triple Exclusion System for AM III

NARKOMED STANDARD

S4105572 A	One vapor w/o shelf or NAD/AV
S4105570 A	One vapor w/ shelf or NAD/AV
S4105573 A	Two vapors, vapor selector valve w/o shelf or NAD/AV
S4105571 A	Two vapors, vapor selector valve w/ shelf or NAD/AV
S4105572 A	One vapor 19 w/o shelf or NAD/AV
S4105570 A	One vapor 19 w/ shelf or NAD/AV
S4105573 A	Two vapor 19's, vapor selector valve w/o shelf or NAD/AV
S4105571 A	Two vapor 19's, vapor selector valve w/ shelf or NAD/AV
S4105570 A	Two vapor 19's w/ double vapor exclusion system including vapor hoses connected to vapor selector valve location
S4105570 A	Two vapor 19's w/ double vapor exclusion system including vapor hoses connected to back of macchine
S4105574 A	Two vapor 19's w/ double vapor exclusion system including chrome plated piping
S000067 A	Two vapor exclusion system - Narkomed Standard

FLOWMETER LIGHTING SYSTEMS

PRODUCT NUMBER	DESCRIPTION
S000088 A	Narkomed 2 - 2 Gas with AV-E
S000089 A	Narkomed 2 - 3 Gas with AV-E
4104740 A	Narkomed 2A - 2 Gas
4106150 A	Narkomed 2A - 3 Gas

AIR GAS CIRCUITS FOR NARKOMED 2, NARKOMED 2A AND NARKOMED STANDARD

NARKOMED STANDARD

S000068 A	Complete Air Circuit
S000070 A	Air DISS to Existing Yoke
S000071 A	Air Yoke to Existing DISS

NARKOMED 2/NARKOMED 2A

S000082 A	Complete Air Ciruit w/ selector switch - Narkomed 2A only
S000072 A	Complete Air Circuit w/o selector switch

S000073 A	Air DISS to Existing Yoke
S000074 A	Air Yoke to Existing DISS

*NOTE: Prices for Conversion Kits do not include the following:

Installation Charges
Travel Charges
Vapor Conversion to Exclusion System
Additional Vapor Vaporizers

TECHNICAL SERVICE FORMS & LABELS

S000086 P	Vapor Concentration Verification Forms & Labels (10 forms, 100 labels)
S000042 P	Preventive Maintenance Forms
S4104641P	Preventive Maintenance Labels

STANDARD HARDWARE

SCREWS

7701000 P Screw - Cap Skt Hd 2-56 x 5/16 L ss
7701001 P Screw - Cap Skt Hd 2-56 x 3/8 L ss
7701002 P Screw - Cap Skt Hd 4-40 x 5/16 L ss
7701003 P Screw - Cap Skt Hd 4-40 x 3/8 L ss
7701004 P Screw - Cap Skt Hd 4-40 x 5/8 L ss
7701005 P Screw - Cap Skt Hd 4-40 x 3/4 L ss
7701006 P Screw - Cap Skt Hd 6-32 x 3/16 L ss
7701007 P Screw - Cap Skt Hd 6-32 x 1/4 L ss
7701008 P Screw - Cap Skt Hd 6-32 x 3/8 L ss
7701009 P Screw - Cap Skt Hd 6-32 x 7/16 L ss
7701010 P Screw - Cap Skt Hd 6-32 x 1/2 L ss
7701011 P Screw - Cap Skt Hd 8-32 x 1/4 L ss
7701012 P Screw - Cap Skt Hd 8-32 x 3/8 L ss
7701013 P Screw - Cap Skt Hd 8-32 x 7/16 L ss
7701014 P Screw - Cap Skt Hd 8-32 x 1/2 L ss
7701015 P Screw - Cap Skt Hd 8-32 x 9/16 L ss
7701016 P Screw - Cap Skt Hd 8-32 x 5/8 L ss
7701017 P Screw - Cap SKt Hd 8-32 x 3/4 L ss
7701018 P Screw - Cap Skt Hd 8-32 x 1 L ss
7701019 P Screw - Cap Skt Hd 8-32 x 1-1/4 L ss
7701020 P Screw - Cap Skt Hd 8-32 x 1-1/2 L ss
7701021 P Screw - Cap Skt Hd 10-32 x 1/4 L ss
7701022 P Screw - Cap Skt Hd 10-32 x 5/16 L ss
7701023 P Screw - Cap Skt Hd 10-32 x 3/8 L ss
7701024 P Screw - Cap Skt Hd 10-32 x 1/2 L S BO
7701025 P Screw - Cap Skt Hd 10-32 x 1/2 L ss
7701026 P Screw - Cap Skt Hd 10-32 x 9/16 L ss
7701027 P Screw - Cap Skt Hd 10-32 x 5/8 L ss
7701028 P Screw - Cap Skt Hd 10-32 x 3/4 L ss
7701029 P Screw - Cap Skt Hd 10-32 x 1 L ss
7701030 P Screw - Cap Skt Hd 10-32 x 1-1/8 L ss
7701031 P Screw - Cap Skt Hd 10-32 x 1-1/2 L ss
7701032 P Screw - Cap Skt Hd 10-32 x 2-1/8 L ss
7701033 P Screw - Cap Skt Hd 1/4-20 x 3/8 L ss
7701034 P Screw - Cap Skt Hd 1/4-20 x 1/2 L ss
7701035 P Screw - Cap Skt Hd 1/4-20 x 5/8 L ss
7701036 P Screw - Cap Skt Hd 1/4-20 x 3/4 L ss
7701037 P Screw - Cap Skt Hd 1/4-20 x 1 L ss
7701038 P Screw - Cap Skt Hd 1/4-20 x 1-1/8 L ss
7701039 P Screw - Cap Skt Hd 1/4-20 x 1-1/4 L ss
7701040 P Screw - Cap Skt Hd 1/4-20 x 1-1/2 L ss
7701041 P Screw - Cap Skt Hd 1/4-20 x 1-5/8 L ss
7701042 P Screw - Cap Skt Hd 1/4-20 x 1-3/4 L ss
7701043 P Screw - Cap Skt Hd 1/4-20 x 2 L ss
7701044 P Screw - Cap Skt Hd 1/4-20 x 2-3/4 L ss
7701045 P Screw - Cap Skt Hd 1/4-28 x 1/4 L ss
7701046 P Screw - Cap Skt Hd 1/4-28 x 3/8 L ss
7701047 P Screw - Cap Skt Hd 1/4-28 x 7/16 L ss
7701048 P Screw - Cap Skt Hd 1/4-28 x 1/2 L ss
7701049 P Screw - Cap Skt Hd 1/4-28 x 5/8 L ss
7701050 P Screw - Cap SKt Hd 1/4-28 x 3/4 L ss
7701051 P Screw - Cap Skt Hd 1/4-28 x 7/8 L ss
7701052 P Screw - Cap Skt Hd 1/4-28 x 1-1/4 L ss
7701053 P Screw - Cap Skt Hd 5/16-18 x 1/2 L ss
7701054 P Screw - Cap Skt Hd 5/16-18 x 3/4 L ss
7701055 P Screw - Cap Skt Hd 5/16-24 x 3/8 S Cd
7701056 P Screw - Cap Skt Hd 5/16-24 x 3/4 L ss
7701057 P Screw - Cap Skt Hd 5/16-24 x 3/4 br CP
7701058 P Screw - Cap Skt Hd 5/16-24 x 1-3/4 ss
7701059 P Screw - Cap Skt Hd 5/16-24 x 2 L ss
7701060 P Screw - Cap Skt Hd 3/8-16 x 1/2 L ss
7701061 P Screw - Cap Skt Hd 3/8-16 x 5/8 L ss
7701062 P Screw - Cap Skt Hd 3/8-16 x 3/4 L S BO
7701063 P Screw - Cap Skt Hd 3/8-16 x 3/4 L ss
7701064 P Screw - Cap Skt Hd 3/8-16 x 1 L ss
7701065 P Screw - Cap Skt Hd M3 x 12 L ss
7701066 P Screw - Cap Skt Hd M4 x 30 x 1-5/16 ss
7701067 P Screw - Cap Skt Hd 6-32 x 5/8 L ss
7701068 P Screw - Cap Skt Hd 5/16-18 x 1/2 S BO
7701069 P Screw - Cap Skt Hd 5/16-24 x 1-1/4 S BO
7701070 P Screw - Cap Skt Hd 10-32 x 7/16 L ss
7701071 P Screw - Cap Skt Hd 3/8-18 x 1 L ss
7701072 P Screw - Cap Skt Hd M4 x 1-3/16 L ss
7701073 P Screw - Cap Skt Hd 3/8-18 x 5/8 L ss
7702000 P Screw - Pan Hd Sltd 2-56 x 1/4 L ss
7702001 P Screw - Pan Hd Sltd 2-56 x 3/16 L ss
7702002 P Screw - Pan Hd Sltd 3-48 x 3/16 L ss
7702003 P Screw - Pan Hd Sltd 3-48 x 3/8 L ss
7702004 P Screw - Pan Hd Sltd 4-40 x 1/4 L ss
7702005 P Screw - Pan Hd Sltd 4-40 x 3/8 L ss
7702006 P Screw - Pan Hd Sltd 4-40 x 1/2 L ss
7702007 P Screw - Pan Hd Sltd 4-40 x 1 L ss
7702008 P Screw - Pan Hd Sltd 4-40 x 1-1/2 L ss
7702009 P Screw - Pan Hd Sltd 6-32 x 1/4 L ss
7702010 P Screw - Pan Hd Sltd 6-32 x 5/16 L ss
7702011 P Screw - Pan Hd Sltd 6-32 x 3/8 L ss
7702012 P Screw - Pan Hd Sltd 6-32 x 1/2 L ss
7702013 P Screw - Pan Hd Sltd 6-32 x 5/8 L ss
7702014 P Screw - Pan Hd Sltd 8-32 x 1/4 L ss
7702015 P Screw - Pan Hd Sltd 8-32 x 3/8 L ss
7702016 P Screw - Pan Hd Sltd 8-32 x 1/2 L ss
7702017 P Screw - Pan Hd Sltd 10-32 x 1/4 L ss
7702018 P Screw - Pan Hd Sltd 10-32 x 3/8 L ss
7702019 P Screw - Pan Hd Sltd 10-32 x 1/2 L ss
7702020 P Screw - Pan Hd Sltd 1/4-20 x 1/2 L ss
7702021 P Screw - Pan Hd Sltd 4-40 x 1-5/16 L ss
7703000 P Screw - Flt Hd Skt 2-56 x 1/4 L ss
7703001 P Screw - Flt Hd Skt 5-40 x 1/4 L ss
7703002 P Screw - Flt Hd Skt 6-32 x 5/16 L ss
7703003 P Screw - Flt Hd Skt 6-32 x 1/2 L ss
7703004 P Screw - Flt Hd Skt 8-32 x 1/4 L ss
7703005 P Screw - Flt Hd Skt 8-32 x 3/8 L ss
7703006 P Screw - Flt Hd Skt 8-32 x 7/16 L ss
7703007 P Screw - Flt Hd Skt 10-32 x 1/4 S BO

7703008 P Screw - Flt Hd Skt 10-32 x 3/8 L ss
7703009 P Screw - Flt Hd Skt 10-32 x 1/2 L ss
7703010 P Screw - Flt Hd Skt 10-32 x 5/8 L ss
7703011 P Screw - Flt Hd Skt 10-32 x 3/4 L ss
7703012 P Screw - Flt Hd Skt 1/4-20 x 1/2 L ss
7703013 P Screw - Flt Hd Skt 1/4-20 x 5/8 L ss
7703014 P Screw - Flt Hd Skt 1/4-20 x 5/8 S Cd
7703015 P Screw - Flt Hd Skt 1/4-28 x 1/2 S Cd
7703016 P Screw - Flt Hd Skt 1/4-28 x 5/8 L ss
7703017 P Screw - Flt Hd Skt 1/4-28 x 1-1/4 L ss
7703018 P Screw - Flt Hd Skt 6-32 x 3/8 L ss
7703019 P Screw - Flt Hd Skt 10-32 x 1/4 L ss
7703200 P Screw - Flt Hd Skt 1/4-20 x 1 L ss
7703021 P Screw - Flt Hd Skt 3/8-16 x 7/8 L ss
7703022 P Screw - Flt Hd Skt 8-32 x 5/16 L ss
7703023 P Screw - Flt Hd Skt 10-32 x 5/16 L ss
7703024 P Screw - Flt Hd Skt 1/4-20 x 2 L ss
7704000 P Screw - Set Cup Pt 2-56 x 1/8 L ss
7704001 P Screw - Set Cup Pt 6-32 x 1/8 L ss
7704002 P Screw - Set Cup Pt 6-32 x 3/16 L ss
7704003 P Screw - Set Cup Pt 6-32 x 1/4 L ss
7704004 P Screw - Set Cup Pt 6-32 x 3/8 L ss
7704005 P Screw - Set Cup Pt 8-32 x 1/8 L ss
7704006 P Screw - Set Cup Pt 8-32 x 3/16 L ss
7704007 P Screw - Set Cup Pt 8-32 x 1/4 L ss
7704008 P Screw - Set Cup Pt 10-32 x 1/8 L ss
7704009 P Screw - Set Cup Pt 10-32 x 1/4 L ss
7704010 P Screw - Set Cup Pt 10-32 x 1/2 L ss
7704011 P Screw - Set Cup Pt 10-32 x 7/8 L ss
7704012 P Screw - Set Cup Pt 10-32x 1-1/4 L ss
7704013 P Screw - Set Cup Pt 1/4-20 x 3/8 L ss
7704014 P Screw - Set Cup Pt 1/4-28 x 1/4 L ss
7704015 P Screw - Set Cup Pt 5/16-24 x 1/4 L ss
7704016 P Screw - Set Cup Pt 3/8-16 x 3/8 L ss
7705000 P Screw - Flt Hd Sltd 2-56 x 3/16 L ss
7705001 P Screw - Flt Hd Sltd 2-56 x 1/4 L ss
7705002 P Screw - Flt Hd Sltd 2-56 x 5/16 L ss
7705003 P Screw - Flt Hd Sltd 4-40 x 3/8 L ss
7705004 P Screw - Flt Hd Sltd 4-40 x 1/2 L ss
7705005 P Screw - Flt Hd Sltd 6-32 x 1/4 L ss
7705006 P Screw - Flt Hd Sltd 6-32 x 3/8 L ss
7705007 P Screw - Flt Hd Sltd 8-32 x 1/4 L ss
7705008 P Screw - Flt Hd Sltd 8-32 x 3/8 L ss
7705009 P Screw - Flt Hd Sltd 10-32 x 1/4 L ss
7705010 P Screw - Flt Hd Sltd 10-32 x 3/4 L ss
7705011 P Screw - Flt Hd Sltd 1/4-20 x 2-2/4 L ss
7705012 P Screw - Flt Hd Sltd M2-X4 L ss
7705013 P Screw - Flt Hd Sltd 8-32 x 5/16 L S BO
7705014 P Screw - Flt Hd Sltd 8-32 x 1/2 L ss
7705015 P Screw - Flt Hd Sltd 1/4-20 x 2-1/4 L ss
7705016 P Screw - Flt Hd Sltd 4-40 x 1/4 L ss
7705017 P Screw - Flt Hd Sltd 6-32 x 1 L ss
7706000 P Screw - Rd Hd Sltd 3-48 x 5/8 L ss
7706001 P Screw - Rd Hd Sltd 4-40 x 1/4 L ss
7706002 P Screw - Rd Hd Sltd 4-40 x 3/8 L ss
7706003 P Screw - Rd Hd Sltd 6-32 x 2-1/2 L ss
7706004 P Screw - Rd Hd Sltd 10-32 x 1/4 L ss
7706005 P Screw - Rd Hd Sltd 10-32 x 5/16 L ss
7706006 P Screw - Rd Hd Sltd 10-32 x 3/8 L ss
7706007 P Screw - Rd Hd Sltd 10-32 x 1/2 L ss
7706008 P Screw - Rd Hd Sltd 10-32 x 5/8 L ss
7706009 P Screw - Rd Hd Sltd 10-32 x 2-1/2 L ss
7706010 P Screw - Rd Hd Sltd 1/4-20 x 1 L ss
7706011 P Screw - Rd Hd Sltd 1/4-20 x 1-1/4 L ss
7706012 P Screw - Rd Hd Sltd 10-24 x 3 L ss
7706013 P Screw - Rd Hd Sltd 6-32 x 2-1/4 L ss
7706014 P Screw - Rd Hd Sltd 1/4-20 x 3-1/2 S CP

STANDARD HARDWARE
SCREWS

7706015 P Screw - Rd Hd Sltd 3-48 x 3/4 L ss
7706016 P Screw - Rd Hd Sltd 6-40 x 2-1/2 L ss
7706017 P Screw - Rd Hd Sltd 10-32 x 1-1/4 L ss
7707000 P Screw - Set Cone Pt 3-48 x 3/16 L ss
7707001 P Screw - Set Cone Pt 6-32 x 1/8 L ss
7707002 P Screw - Set Cone Pt 6-32 x 3/16 L ss
7707003 P Screw - Set Cone Pt 6-32 x 1/4 L ss
7707004 P Screw - Set Cone Pt 8-32 x 1/4 L ss
7707005 P Screw - Set Cone Pt 10-32 x 1/4 L ss
7708000 P Screw - Cap Hex Hd 10-32 x 1 L ss
7708001 P Screw - Cap Hex Hd 3/8-16 x 1-1/2 L ss
7708002 P Screw - Cap Hex Hd 3/8-16 x 2 L S Cd
7708003 P Screw - Cap Hex Hd 3/8-16 x 2-3/4 L ss
7708004 P Screw - Cap Hex Hd 3/8-16 x 3 L S Cd
7708005 P Screw - Cap Hex Hd 3/8-16 x 2 L ss
7709000 P Screw - Btn Skt 6-32 x 3/8 L S NP
7710000 P Screw - Set Cup w/ NY 8-32 x 1/4 L ss
7710001 P Screw - Set Cup w/ NY 10-32 x 1/2 S BO
7711000 P Screw - Drive Rd Hd 0 x 3/16 L ss
7712000 P Screw - Flt Hd Sltd S/Tap 6B x 3/8 ss
7713000 P Screw - Pan Hd Sltd S/Tap 6B x 1/2 ss
7714000 P Screw - Set Flt Pt 8-32 x 7/16 L ss
7714001 P Screw - Set Flt Pt 2-56 x 1/8 L S BO

STANDARD HARDWARE

NUTS

7553002 P Nut - Hex Panel 5/8-18 ss
7750000 P Nut - Hex 2-56 ss
7750001 P Nut - Hex 3-48 ss
7750002 P Nut - Hex 4-40 ss
7750003 P Nut - Hex 6-32 ss
7750004 P Nut - Hex 8-32 ss
7750005 P Nut - Hex 10-32 ss
7750006 P Nut - Hex 1/2-20 ss
7750007 P Nut - Hex 1/4-28 ss
7750008 P Nut - Hex 5/16-18 ss
7750009 P Nut - Hex 5/16-24 ss
7750010 P Nut - Hex 3/8-16 ss
7750011 P Nut - Hex 3/8-18 ss
7750012 P Nut - Hex 5/8-18 ss
7750013 P Nut - Hex 3/4-16 ss
7750014 P Nut - Hex 8-32 br
7750015 P Nut - Hex 4-40 br
7750016 P Nut - Hex 6-40 br ss
7751000 P Nut - Acorn 10-32 br CP
7751001 P Nut - Acorn 1/4-20 br CP
7751002 P Nut - Acorn 3/8-16 ss
7751003 P Nut - Acorn 3/8-16 br CP
7752000 P Nut - Hex Jam 3/8-18 ss
7752001 P Nut - Hex Jam 1/2-20 ss
7752002 P Nut - Hex Jam 5/8-18 ss
7752003 P Nut - Hex Jam 3/4-16 ss
7753000 P Nut - Hex Panel 5/8-18 br CP
7753001 P Nut - Hex Panel 3/4-16 ss
7754000 P Nut - Lock 3/8-18 NPT S ZP

STANDARD HARDWARE

WASHERS

7765000 P Washer - Lock Split 4 ss
7765001 P Washer - Lock Split 6 ss
7765002 P Washer - Lock Split 8 S CP
7765003 P Washer - Lock Split 10 ss
7765004 P Washer - Lock Split 1/4 S CP
7765005 P Washer - Lock Split 5/16 ss
7765006 P Washer - Lock Split 3/8 ss
7765007 P Washer - Lock Split 1/2 ss
7765008 P Washer - Lock Split 5/8 ss
7765009 P Washer - Lock Split 3/4 ss
7765010 P Washer - Lock Split 1/4 ss
7765011 P Washer - Lock Split 8 ss
7765012 P Washer - Lock Split 5/8 ss
7766000 P Washer - Flt 3 ss
7766001 P Washer - Flt 4 ss
7766002 P Washer - Flt 8 ss
7766003 P Washer - Flt 10 ss
7766004 P Washer - Flt 1/4 ss
7766005 P Washer - Flt 3/8 ss
7766006 P Washer - Flt 6 ss
7767000 P Washer - Lock Int-T 8 ss
7767001 P Washer - Lock Int-T 5/8 ss
7767002 P Washer - Lock Int-T 3/4 ss
7767003 P Washer - Lock Int-T 1-3/8 S Cd
7768000 P Washer - Lock Ext-T 6 ss
7768001 P Washer - Lock Ext-T 8 ss
7768002 P Washer - Lock Ext-T 10 ss

STANDARD HARDWARE

PINS

7775000 P Pin - Roll .062 D x 1/4 L ss
7775001 P Pin - Roll .093 D x 1/2 L ss
7775002 P Pin - Roll .125 D x 1/2 L ss
7775003 P Pin - Roll .187 D x 5/8 L ss
7775004 P Pin - Roll .187 D x 1 L ss
7775005 P Pin - Roll .250 D x 1 L ss
7775006 P Pin - Roll .125 D x 3/8 L ss
7776000 P Pin Dowel .062 D x 1/8 L ss
7776001 P Pin Dowel .093 D x 1/4 L ss
7776002 P Pin Dowel .187 D x 3/4 L ss
7776003 P Pin Dowel .250 D x 5/8 L ss
7776004 P Pin Dowel .093 D x 3/8 L ss

TEST INSTRUMENTS AND SUPPLIES

S4105465 A Pressure Switch Tester
S000058 A Flowmeter Test Stand
S000063 A Test Gauge O_2 Regulator
S000064 A Test Gauge N_2O Regulator
S000083 A Test Gauge O_2 Pipeline
S000084 A Test Gauge N_2O Pipeline
S4105908 A Dow Corning High Vacuum Grease

MISCELLANEOUS PARTS

PRODUCT NUMBER		DESCRIPTION
4105123	P	Battery - 9 Volt
S2123178	P	O-Ring for vapor 19 Filler Plug
2121805	P	Diaphragm ORM
4103910	P	Flowmeter O_2 (Fine) - NMS w/ ORM
4103909	P	Flowmeter N_2O (Fine) - NMS w/ ORM
4104581	P	Diaphragm ORMc
1101093	P	Flowmeter O_2 - Dual Taper
1101094	P	Flowmeter N_2O - Dual Taper

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Part Number: S002000 (NARKOMED 2A Parts Manual)

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